

(100)

5M 42 568

the slack not
run out yet

Propellant Tank
STRUCTURE

FACILITY FORM 602

(ACCESSION NUMBER)

119

(THRU)

none

(CODE)

(PAGES)

CR - 112343

(CATEGORY)



N70-75444

Appendix I

STRUCTURAL TESTS SUMMARY

Structural testing of the Saturn S-IV Propellant Tanks and Common Dome Assembly was conducted at the Douglas Aircraft Company's Santa Monica Plant Structural Test Laboratory. Testing was begun in April 1962 and concluded in June 1962.

Following is a brief summary of the various tests carried out on the aforementioned assembly; and their results:

A. Hydrostatic Test Vehicle Prior Test (Report No. ST-38341).

This test was conducted to determine the strength characteristics of the Propellant Tanks and Common Dome under simulated ground loading conditions at ambient temperature, based upon DAC Propulsion Report No. 4-147, dated 17 April 1961. The test article consisted of a 5865999 Tank Assembly and a 5871668 Thrust Structure. The simulated ground loading conditions were as follows:

- 1) Pressurization of the LOX tank to 10 psig, and application of vertical loads at the six thrust structure engine fittings (1600 lb. each), to simulate the dead weight of the six RL 10-A engines.
- 2) Pressurization of the LOX Tank to 41.5 psig to provide the Common Dome "limit" pressure.
- 3) Pressurization of both the LOX and LH₂ tanks (3 and 12.8 psig respectively) to provide a "limit reverse pressure" on the Common Dome.
- 4) Pressurization of both tanks (54 psig LOX tank, 24 psig LH₂ tank) to obtain the LOX tank "limit" pressures.
- 5) Both tanks pressurized (40 psig LOX tank, 33.4 psig LH₂ tank) to obtain the LH₂ tank "limit" pressure.
Water was employed as the pressurizing medium.

Instrumentation, which was monitored during this test consisted of nine strain gage rosettes located in the area of the joint between

the common dome and the aft dome, one strain gage rosette on the cylinder, and sixteen deflection potentiometers located so as to provide radial deflections of the aft dome and cylinder.

Maximum meridional stress in the Common Dome due to limit pressure listed in Item 2, was 26,600 psi tension on the .025 skin, and 11,750 psi tension in the .047 skin. Meridional stresses for the Common Dome "reverse limit pressure" were 20,000 psi compression in the .025 skin and 4250 psi compression in the .047 skin.

The maximum meridional stress in the aft dome due to "limit" pressure, (Item 4) as recorded at the center of a waffle panel, was 13,900 psi tension. The maximum hoop stress in the LE₂ tank cylindrical section due to "limit" pressure, (Item 5) as recorded at the center of a waffle panel, was 30,000 psi tension.

In no case were the recorded deflections of the pressurized tank in excess of .25 in.

Final inspection of the Propellant Tanks and Common Dome revealed no indication of damage.

B. Cryogenic Test of the Common Bulkhead in the Hydrostatic Vehicle (Report No. SI-41205)

The purpose of this test was to prove the structural integrity of the Common Dome (P/N 5663806) when subjected to "normal limit pressure" (36.8 psig in LOX tank) and "reverse limit pressure" (26.8 psig in LN₂ tank) at cryogenic temperatures. Liquid nitrogen was used as the pressurizing medium.

Inspection of the carbon skin after each of the two test conditions revealed no structural damage. Ultrasonic testing on both surfaces of the test item indicated that there was no delamination of the aluminum skin from the honeycomb core.

Originally it was intended that the hydrostatic tank assembly would be pressurized until rupture occurred; however, upon request from NASA, the assembly was diverted for use as the "Dynamics/Hydrostatic" Test Vehicle.

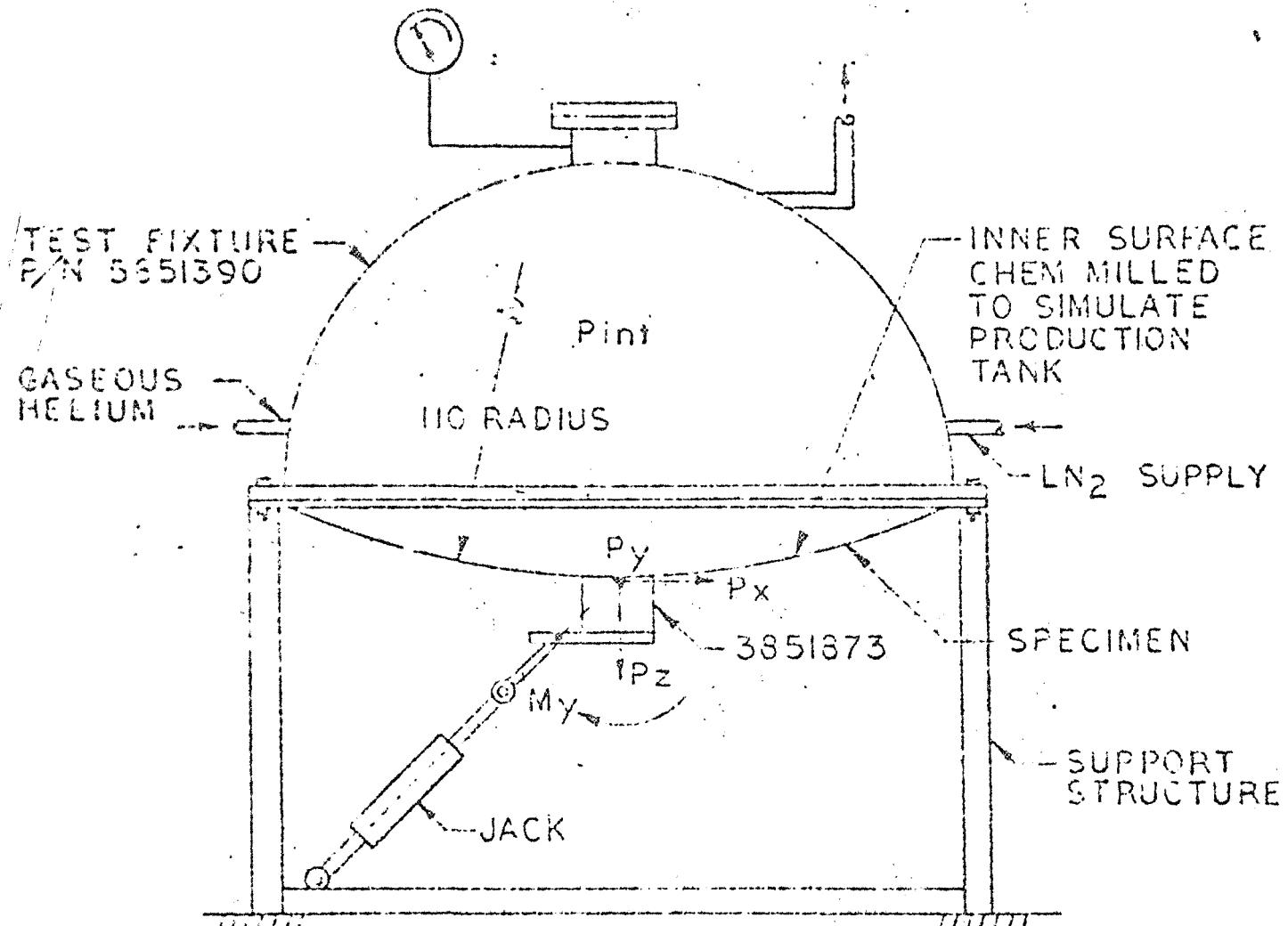
APPENDIX II

Typical Trunk Outlet Tests

This appendix outlines two proposed test plans that have been established to supplement the analyses presented in Section 9 of this report. The proposed tests are the LH₂ vent, shown on page II.1, and the LO₂ fill line shown on page II.2.

Authorization to implement these test plans was received on December 9, 1963. Consequently, no test data is available as of the date of the initial release of this report. As soon as the test program is completed, the results will be transmitted to MSFC.

LH₂ VENT LINE TEST SET-UP PAGE II.1



LOAD CONDITIONS

Pint = 44 PSIG.

Py = 0

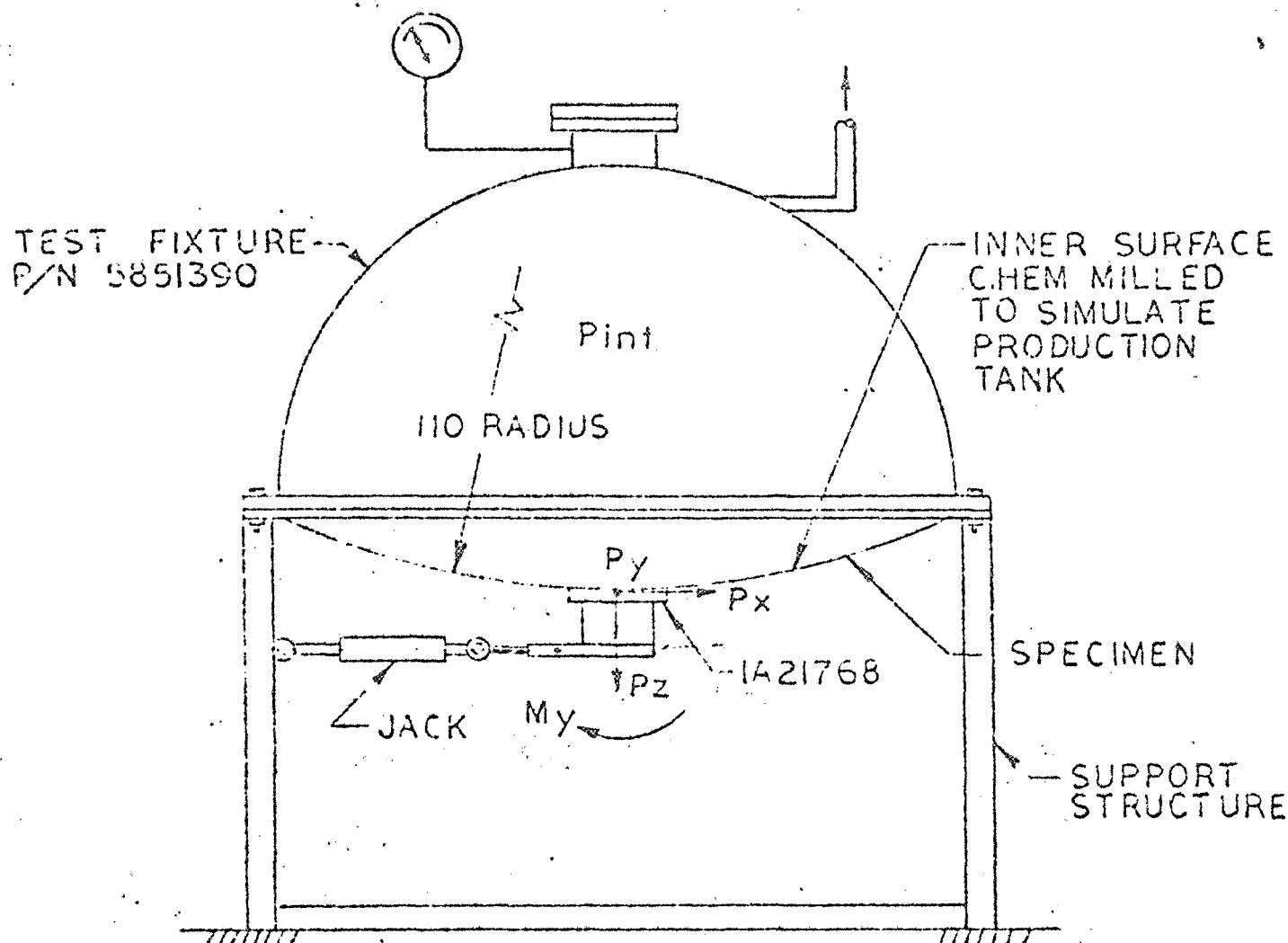
Px	0	-395	-790	-1185	-1580	-1975	-2070
Pz	0	456	916	1375	1830	2290	2400
My	0	3000	6000	9000	12000	15000	15750

→ FAILURE

(REF. P 9.1.9)

LO₂ FILL LINE TEST SET-UP

PAGE III.2



LOAD CONDITIONS

$$P_{int} = 0 \text{ PSIG}$$

$$P_y = 0$$

$$P_z = 0$$

My	0	3000	6000	7310	9,780
Px	0	-389	-779	-950	-1,280

→ FAILURE

(REF P 10.2.6)

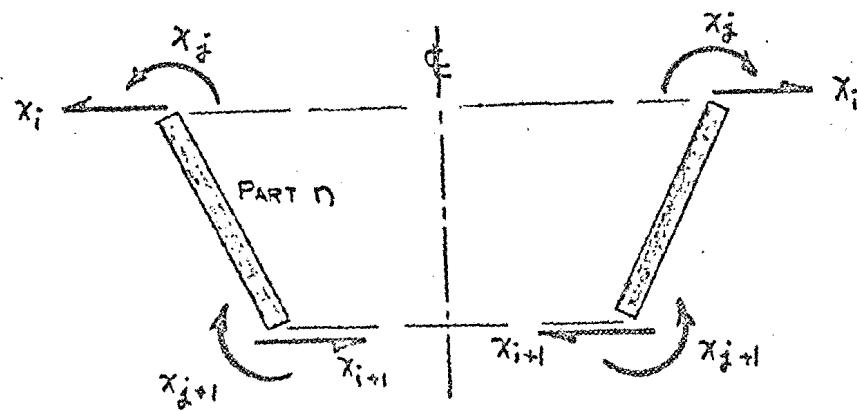
Appendix III

This section deals with the equation derivations used throughout the analyses. The derivations shown are for the general case, that is, any combination of loads and forces can be substituted into the equations, however, geometry changes are restricted.

These derivations fall into two categories, the membrane load derivations and the relative deflection derivations. The membrane load derivations section Page III.2.0 headed by an introduction that explains the methods, signs, and symbols.

The convention used in the relative deflection analysis is as follows. The deflection of a part is symbolized by δ . This deflection can be either rotation or translation perpendicular to the geometric center line of revolution. The part to be analyzed is idealized by cutting it at various spots. Each segment, resulting from this cutting is given a number 1, 2, ... --- n. The deflection of part n is shown as δ^n .

Redundant forces are imposed on the cut surfaces:



Both moment and shear forces are given the designation of X . The deflection of part i in the direction and position of force X_i would be shown as δ_i^n , or in direction and position of force X_{j+1} as δ_{j+1}^n . If the force causing the deflection was X_i , the deflection in direction and position of X_i would be shown as $\delta_{i,i}^n$. If the force causing the deflection in the direction and position of X_i was X_{j+1} it would be shown as $\delta_{i,j+1}^n$; if it were pressure force it would be shown as $\delta_{i,p}^n$.

It can now be seen that the total deflection in the direction and position of X_i is $\delta_i^n = \delta_{i,i}^n + \delta_{i,(i+1)}^n + \delta_{i,j}^n + \delta_{i,p}^n + \text{etc.}$

When the deflection of all the parts due to all the forces acting on it is determined, simultaneous equations are set up such that their solution will result in values for X_i X_j which will cause $\delta_i^n = \delta_i^{n+1}$ and $\delta_j^n = \delta_j^{n+1}$. When the interface deflections are computable, the problem has been solved and the redundant force values are known.

DOUGLAS AIRCRAFT COMPANY, INC.

PREPARED BY: J. J. J.CHECKED BY: G. R. S.DATE: 10-26-53TITLE: 1-54-42 METAL DOME TEST

5/1

DIVISION

PAGE: III, 1, 0MODEL: D-3-Y-4REPORT NO. DP-102-2SIMPLIFIED THERMAL DOMECURE STRESS
FACE STRESSI- THERMAL

$$\sigma_{t,1}' = \frac{\chi_1 R^2 (1-\nu)}{2 E_1 \kappa_1}$$

$$\sigma_{t,T}' = -\alpha \Delta T_1 R$$

$$\sigma_{t,1}^2 = \frac{\chi_1 R^2 (1-\nu)}{2 E_2 \kappa_2}$$

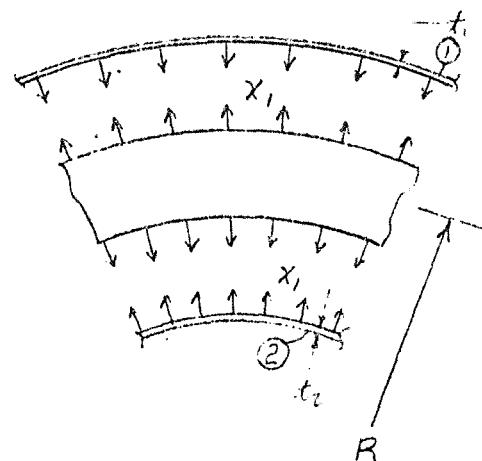
$$\sigma_{t,T}^2 = \alpha \Delta T_2 R$$

$$\delta_t = \sigma_{t,1}' + \sigma_{t,T}' + \sigma_{t,1}^2 + \sigma_{t,T}^2 = 0$$

$$\therefore \chi_1 = \frac{(\alpha \Delta T_1 - \alpha \Delta T_2)}{R(1-\nu) \left(\frac{1}{E_1 \kappa_1} + \frac{1}{E_2 \kappa_2} \right)} \quad (1)$$

$$\sigma_1 = -\frac{\chi_1 R}{2 \kappa_1} = -\frac{(\alpha \Delta T_1 - \alpha \Delta T_2)}{\kappa_1 (1-\nu) \left(\frac{1}{E_1 \kappa_1} + \frac{1}{E_2 \kappa_2} \right)} \quad (2)$$

$$\sigma_2 = \frac{\chi_1 R}{2 \kappa_2} = \frac{(\alpha \Delta T_1 - \alpha \Delta T_2)}{\kappa_2 (1-\nu) \left(\frac{1}{E_1 \kappa_1} + \frac{1}{E_2 \kappa_2} \right)} \quad (3)$$



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PREPARED BY: S. S. C.
 CHECKED BY: M.
 DATE: 12-28-52
 TITLE: Laminated Composite Laminates

PAGE: III, 1.1
 DIVISION: DESIGN
 MODEL: DS V-7
 REPORT NO: DS-1000

II - INTERNAL PRESSURE

$$S_{11}' = \frac{\chi_1 R^2 (1-\nu)}{2 E_1 \chi_1}$$

$$S_{1P}' = 0$$

$$S_{22}' = \frac{\chi_2 R^2 (1-\nu)}{2 E_2 \chi_2}$$

$$S_{1P}'' = \frac{P_2 R^2 (1-\nu)}{2 E_2 \chi_2}$$

$$S_1 = S_{11}' + S_{1P}'' + S_{22}' + S_{1P}''' = 0$$

$$\chi_1 = \frac{-P_2 E_1 \chi_1}{(E_1 \chi_1 + E_2 \chi_2)} \quad (4)$$

$$\sigma_1 = -\frac{\chi_1 R}{2 \chi_1} = \frac{P_2 E_1 R}{2(E_1 \chi_1 + E_2 \chi_2)} \quad (5)$$

$$\sigma_2 = \frac{(P_2 + \chi_1) R}{2 \chi_2} = \frac{P_2 E_2 R}{2(E_1 \chi_1 + E_2 \chi_2)} \quad (6)$$

III - EXTERNAL PRESSURE

$$S_{11}' = \frac{\chi_1 R^2 (1-\nu)}{2 E_1 \chi_1}$$

$$S_{1P}' = -\frac{P_1 R^2 (1-\nu)}{2 E_1 \chi_1}$$

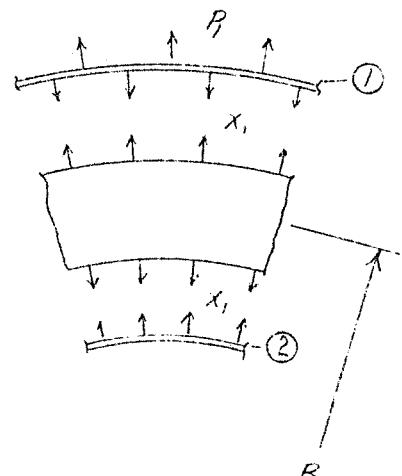
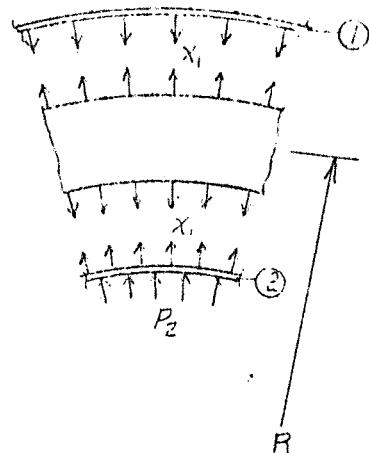
$$S_{22}' = \frac{\chi_2 R^2 (1-\nu)}{2 E_2 \chi_2}$$

$$S_{1P}''' = 0$$

$$S_1 = S_{11}' + S_{1P}'' + S_{22}' + S_{1P}''' = 0$$

$$\chi_1 = \frac{P_1 E_2 \chi_2}{(E_1 \chi_1 + E_2 \chi_2)} \quad (7)$$

$$\sigma_1 = \frac{(P_1 - \chi_1) R}{2 \chi_1} = \frac{P_1 E_1 R}{2(E_1 \chi_1 + E_2 \chi_2)} \quad (8)$$



DOUGLAS AIRCRAFT COMPANY, INC.

PREPARED BY: G. J. S.

PAGE: 1

CHECKED BY: G. J. S.

SM

DIVISION

DATE: 12-12-2

MODEL: DC-3

TITLE: DESIGN OF AEROSTATIC TANK

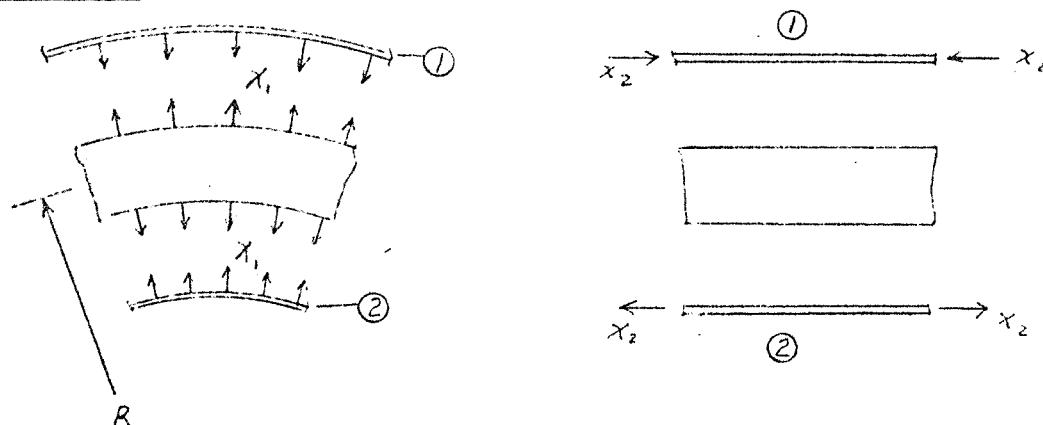
REPORT NO: 3

$$\sigma_2 = \frac{\chi_1 R}{2x_2} = \frac{P_1 E_2 R}{2(E_1 \epsilon_1 + E_2 x_2)} \quad (9)$$

SANDWICH CYLINDER

CORE STRESS

FACE STRESS

I- THERMAL

$$\sigma'_{1,1} = \frac{\chi_1 P^2}{E_1 \epsilon_1}$$

$$\sigma^2_{1,1} = \frac{\chi_1 R^2}{E_2 x_2}$$

$$\sigma'_{1,2} = -\nu x_2 R / E_1 \epsilon_1$$

$$\sigma^2_{1,2} = -\nu x_2 R / E_2 x_2$$

$$\sigma'_{2,1} = -\nu x_1 R / E_1 \epsilon_1$$

$$\sigma^2_{2,1} = -\nu x_1 R / E_2 x_2$$

$$\sigma'_{2,2} = \frac{x_2}{E_1 \epsilon_1}$$

$$\sigma^2_{2,2} = \frac{x_2}{E_2 x_2}$$

$$\sigma'_{1,T} = -\alpha \Delta T_1 R$$

$$\sigma^2_{1,T} = \alpha \Delta T_2 R$$

$$\sigma'_{2,T} = -\alpha \Delta T_1$$

$$\sigma^2_{2,T} = \alpha \Delta T_2$$

$$\Sigma_1 = \sigma'_{1,1} + \sigma'_{1,2} + \sigma'_{1,T} + \sigma^2_{1,1} + \sigma^2_{1,2} + \sigma^2_{1,T} = 0$$

$$\Sigma_2 = \sigma'_{2,1} + \sigma'_{2,2} + \sigma'_{2,T} + \sigma^2_{2,1} + \sigma^2_{2,2} + \sigma^2_{2,T} = 0$$

$$\therefore \chi_2 = \frac{(\alpha \Delta T_1 - \alpha \Delta T_2)}{(1-\nu)(\frac{1}{E_1 \epsilon_1} + \frac{1}{E_2 x_2})} \quad (1)$$

$$\chi_1 = \frac{(-\Delta T_1 - \Delta T_2)}{(1-\nu)R(\frac{1}{E_1 \epsilon_1} + \frac{1}{E_2 x_2})} \quad (2)$$

PREPARED BY R.R. MEYER
CHECKED BY J.F. MEYERS
DATE 8-12-61
TITLE DSV-4 PROPELLANT TANK

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SM

DIVISION

PAGE III.2.0
MODEL DSV-4

REPORT NO. SH 42569

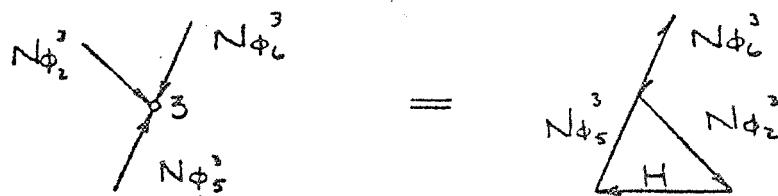
MEMBRANE ANALYSIS

THE OBJECT OF THIS ANALYSIS IS TO DETERMINE THE MEMBRANE STRESSES IN THE SHELL SHOWN IN FIGURE PAGE III.2.2, CAUSED BY INTERNAL PRESSURE AND VERTICAL ACCELERATION LOADS ON THE PROPELLANT FLUID MASSES (NEGLECTING THE MASS OF THE TANK ITSELF). ACCELERATION LOADS ARE DERIVED BY MEANS OF D'ALEMBERT'S PRINCIPLE OF APPLYING REVERSED ACCELERATION BODY FORCES ON THE ELEMENTS OF MASS AND TREATING THE PROBLEM AS AN EQUILIBRIUM ONE (INSTEAD OF $F=ma$, USING $F-ma=0$).

THE SEQUENCE OF COMPUTATION IS IMPORTANT IN CERTAIN REGIONS, DEPENDING UPON THE FIRING CONDITION, SINCE INTERNAL STRESSES SOMETIMES DEPEND UPON BOUNDARY LOADS FROM ADJACENT ELEMENTS. FOR STRESSES $N_{\phi 4}$, $N_{\phi 5}$ AND $N_{\phi 6}$ THIS IS THE CASE, AND TWO SOLUTIONS HAVE BEEN PROVIDED WHICH ACT AS A CHECK ON THE BOUNDARY LOADS. SINCE $N_{\phi 4}$ AND $N_{\phi 6}$ ARE POSITIVE FOR TENSION, AND BOUNDARY LOADS HAVE BEEN APPLIED IN CONFORMITY WITH THIS CONVENTION, DIRECT ALGEBRAIC SUBSTITUTION OF THE COMPUTED BOUNDARY LOADS RESULTS IN CORRECT SIGNS.

EQUILIBRIUM IN THE HORIZONTAL DIRECTION AT POINTS WHERE SHELL ELEMENTS JOIN AT AN ANGLE TO EACH OTHER MUST BE ACCOUNTED FOR BY HORIZONTAL SHEARS APPLIED TO ONE OF THE ELEMENTS OR TO A RING AT THE JOINT.

E.G. POINT 3, PAGE III.2.2



H = REQUIRED SHEAR REACTION FROM ONE ELEMENT (OR RING REACTION) ON POINT.

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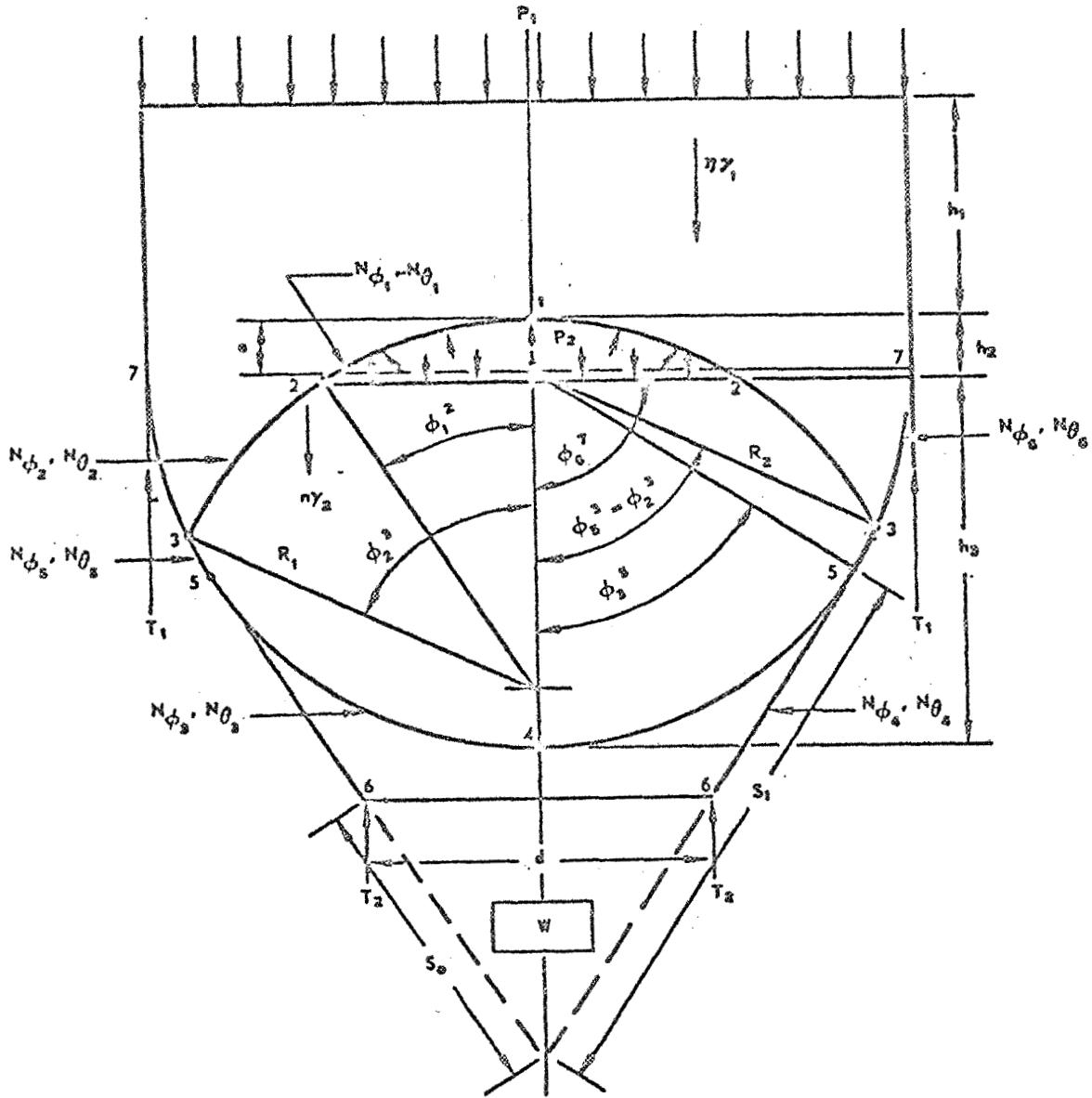
DIVISION

PAGE III.2.1MODEL DSV-4REPORT NO. SM 42569

NOTATION

p_1	GAS PRESSURE IN FUEL TANK, PSIG
p_2	GAS PRESSURE IN OXIDIZER TANK, PSIG
η	VERTICAL ACCELERATION LOAD FACTOR
h_1, h_2, h_3	FILL HEIGHTS GIVEN ON DIII.2.2, INCHES
a	DISTANCE GIVEN ON DIII.2.2, INCHES
s_0, s_1	DISTANCES TO THRUST STRUCTURE CONE APEX GIVEN ON PAGE 14.3, INCHES
R_1, R_2	SPHERICAL RADII GIVEN ON P.14.3, INCHES
d	BASE DIAMETER OF THRUST STRUCTURE, INCHES
γ_1	DENSITY OF FUEL, LBS/IN ³
γ_2	DENSITY OF OXIDIZER, LBS/IN ³
w	WEIGHT OF ENGINES, EQUIPMENT, ETC., LBS.
T_1	THRUST IN CYLINDER DUE TO FIRST STAGE FIRING, LBS/IN.
T_2	THRUST AT BASE OF CONE DUE TO SECOND STAGE FIRING, LBS/IN.
$\phi_{1...7}^{1...7}$	MERIDIAN ANGLE IN REGION 1...6 (SUBSCRIPT) GIVEN AT POINT 1...7 (SUPERSCRIPT)
$N_{\phi_{1...6}}^{1...7}$	MERIDIAN LOAD IN REGION 1...6 (SUBSCRIPT) GIVEN AT POINT 1...7 (SUPERSCRIPT), LBS/IN.
$N_{\theta_{1...6}}^{1...7}$	HOOP LOAD IN REGION 1...6 (SUBSCRIPT) GIVEN AT POINT 1...7 (SUPERSCRIPT), LBS/IN.
q	NORMAL PRESSURE AT POINT ON THE SHELL (POSITIVE OUTWARD)
Q	INTEGRAL OF q IN THE VERTICAL DIRECTION OVER A SURFACE

NOTATION, MEMBRANE LOADS



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PAGE III.2.3
 DIVISION DSV-4
 REPORT NO. SM 42569

REGION

① - ②

$N_{\phi 1}$

$N_{\phi 1} \sin \phi_1$

$N_{\phi 1}$

R

p_1

$m g_1$

$$h_1, h = h_1 + R(1 - \cos \phi)$$

$N_{\phi 1}$

q

$d\phi$

dr

ϕ_1

ϕ

FROM THE GEOMETRY ABOVE :

$$r = R \sin \phi \quad d(R \sin \phi) = R \cos \phi \cdot d\phi$$

THE VERTICAL LOADING PRESSURE, q , ACTS ON AN ELEMENTARY ANNULAR RING OF SIZE:

$$dA = 2\pi r dr = 2\pi R^2 \sin \phi \cos \phi d\phi$$

THE TOTAL VERTICAL PRESSURE LOADING, Q , WILL BE GIVEN BY:

$$\frac{Q}{2\pi R^2} = \int_0^{\phi_1} q \sin \phi \cos \phi d\phi \quad (1)$$

FROM THE ABOVE GEOMETRY,

$$q = p_2 - p_1 - m g_1 h = p_2 - p_1 - m g_1 (h_1 + R - R \cos \phi)$$

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DIVISION

PAGE III.2.4

MODEL DSV-4

REPORT NO. SII 42569

SUBSTITUTING q INTO EQ. (1) :

$$\begin{aligned} \frac{Q}{2\pi R^2} &= \int_0^{\phi_1} \left\{ p_2 - p_1 - \gamma g_1 (h_1 + R - R \cos \phi) \right\} \sin \phi \cos \phi d\phi \\ &= \int_0^{\phi_1} \left\{ p_2 - p_1 - \gamma g_1 (h_1 + R) \right\} \sin \phi \cos \phi d\phi \\ &\quad + \int_0^{\phi_1} R \gamma g_1 \cos^2 \phi \sin \phi d\phi \\ &= \left\{ p_2 - p_1 - \gamma g_1 (h_1 + R) \right\} \left[\frac{\sin^2 \phi}{2} \right]_0^{\phi_1} \\ &\quad - R \gamma g_1 \left[\frac{\cos^3 \phi}{3} \right]_0^{\phi_1} \\ \frac{Q}{2\pi R^2} &= \frac{1}{2} \left\{ p_2 - p_1 - \gamma g_1 (h_1 + R) \right\} \sin^2 \phi_1 \\ &\quad - \frac{1}{3} R \gamma g_1 (\cos^3 \phi_1 - 1). \end{aligned} \quad (2)$$

FOR VERTICAL EQUILIBRIUM :

$$N_{\phi_1} \sin \phi_1 \cdot 2\pi R \sin \phi_1 - Q = 0 \quad (3)$$

SUBSTITUTING (2) INTO (3) GIVES :

$$\begin{aligned} 2\pi R \sin^2 \phi_1 N_{\phi_1} &= 2\pi R^2 \cdot \left[\frac{1}{2} \left\{ p_2 - p_1 - \gamma g_1 (h_1 + R) \right\} \sin^2 \phi_1 \right. \\ &\quad \left. - \frac{1}{3} R \gamma g_1 (\cos^3 \phi_1 - 1) \right] \end{aligned}$$

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DIVISION

PAGE III.2.5

MODEL DSV-4

REPORT NO. SM 42569

SOLVING FOR N_{ϕ_1} :

$$N_{\phi_1} = \frac{R}{2} \left\{ p_2 - p_1 - \gamma g_1 (h_1 + R) \right\} - \frac{R^2}{3} \gamma g_1 \frac{\cos^3 \phi_1 - 1}{\sin^2 \phi_1} \quad (4)$$

THE EQUATION OF NORMAL EQUILIBRIUM OF
AN ELEMENT OF A SHELL IS:

$$\frac{N_{\phi}}{r_1} + \frac{N_{\theta}}{r_2} = q$$

FOR A SPHERE, $r_2 = r_1 = R$ AND THE
EXPRESSION FOR N_{θ} BECOMES:

$$N_{\theta} = -N_{\phi} + qR \quad (5)$$

SUBSTITUTING THE VALUE OF q FROM P. III.2.3
FOR $\phi = \phi_1$.

$$N_{\theta_1} = -N_{\phi_1} + R \left\{ p_2 - p_1 - \gamma g_1 (h_1 + R - R \cos \phi_1) \right\} \quad (6)$$

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DATE 7-27-60

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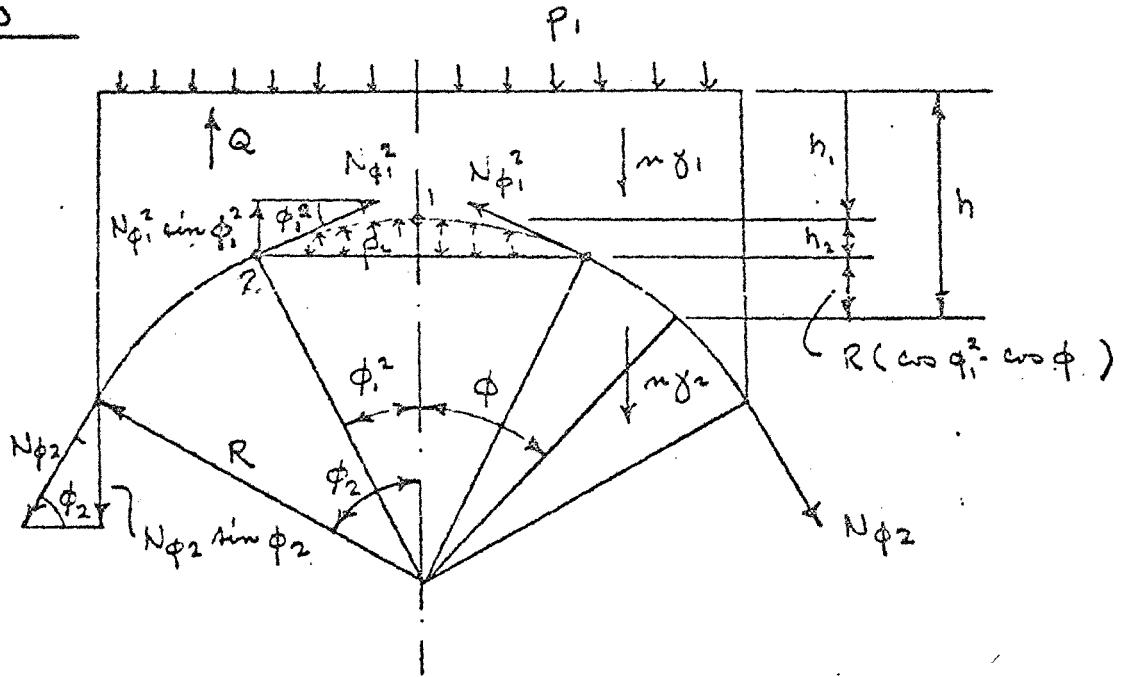
PAGE III. 2.6
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REGION

② ③

N_{ϕ_2}



AT DEPTH h , THE PRESSURE ON THE TOP, q_1 , IS:

$$q_1 = -p_1 - m\gamma_1 h = -p_1 - m\gamma_1 \{ h_1 + h_2 + R(\cos\phi_1^2 - \cos\phi) \}$$

THE PRESSURE AT THE BOTTOM, q_2 , IS:

$$q_2 = p_2 + m\gamma_2 R (\cos\phi_1^2 - \cos\phi) \quad \text{WHICH IS A HYDROSTATIC UPLIFT.}$$

THE TOTAL RESULTANT PRESSURE, q , IS:

$$q = q_1 + q_2 = p_2 - p_1 + m\gamma_2 R (\cos\phi_1^2 - \cos\phi) - m\gamma_1 \{ h_1 + h_2 + R(\cos\phi_1^2 - \cos\phi) \}$$

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SUBSTITUTING THIS VALUE INTO EQ. (1)
 FOR THE TOTAL VERTICAL PRESSURE LOADING
 GIVES:

$$\begin{aligned}
 \frac{Q}{2\pi R^2} &= \int_{\phi_1}^{\phi_2} \left[p_2 - p_1 + n \gamma_2 R (\cos \phi_i^2 - \cos \phi) - \right. \\
 &\quad \left. - n \gamma_1 \{ h_1 + h_2 + R (\cos \phi_i^2 - \cos \phi) \} \right] \sin \phi \cos \phi d\phi \\
 &= \int_{\phi_1}^{\phi_2} \left\{ p_2 - p_1 + n \gamma_2 R \cos \phi_i^2 - n \gamma_1 (h_1 + h_2 + R \cos \phi_i^2) \right\} \times \\
 &\quad \times \sin \phi \cos \phi d\phi \\
 &- \left(\int_{\phi_1}^{\phi_2} \{ n \gamma_2 R - n \gamma_1 R \} \cos^2 \phi \sin \phi d\phi \right. \\
 &= \{ p_2 - p_1 - n R (\gamma_1 - \gamma_2) \cos \phi_i^2 - n \gamma_1 (h_1 + h_2) \} \left[\frac{\sin^2 \phi}{2} \right]_{\phi_1}^{\phi_2} \\
 &- n R (\gamma_1 - \gamma_2) \left[\frac{\cos^3 \phi}{3} \right]_{\phi_1}^{\phi_2} \\
 \frac{Q}{2\pi R^2} &= \frac{1}{2} \{ p_2 - p_1 - n R (\gamma_1 - \gamma_2) \cos \phi_i^2 - n \gamma_1 (h_1 + h_2) \} (\sin^2 \phi_2 - \sin^2 \phi_1) \\
 &- \frac{1}{3} n R (\gamma_1 - \gamma_2) (\cos^3 \phi_2 - \cos^3 \phi_1)
 \end{aligned}$$

PREPARED BY D. D. HAYRN
 CHECKED BY L. D. H. 7/29/60
 DATE 7-27-66
 TITLE DSV-4 PROPELANT TANK

Douglas Aircraft Company, Inc.

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DIVISION

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MODEL DSV-4

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FOR VERTICAL EQUILIBRIUM: (P III.2.6)

$$N_{\phi_2} \sin \phi_2 \cdot 2\pi R \sin \phi_2 - N_{\phi_1}^2 \sin \phi_1^2 \cdot 2\pi R \sin \phi_1^2 - Q = 0$$

SUBSTITUTING FOR Q:

$$2\pi R \sin^2 \phi_2 N_{\phi_2} - 2\pi R \sin^2 \phi_1^2 N_{\phi_1}^2 = 2\pi R^2 \left[\frac{1}{2} \left\{ p_2 - p_1 - mR(\gamma_1 - \gamma_2) \cos \phi_1^2 - mg_1(h_1 + h_2) \right\} (\sin^2 \phi_2 - \sin^2 \phi_1^2) - \frac{1}{3} mR(\gamma_1 - \gamma_2) (\cos^3 \phi_2 - \cos^3 \phi_1^2) \right].$$

SOLVING FOR N_{ϕ_2} :

$$N_{\phi_2} = N_{\phi_1}^2 \left(\frac{\sin \phi_1^2}{\sin \phi_2} \right)^2 + \frac{R}{2} \left\{ p_2 - p_1 - mR(\gamma_1 - \gamma_2) \cos \phi_1^2 - mg_1(h_1 + h_2) \right\} \left[1 - \left(\frac{\sin \phi_1^2}{\sin \phi_2} \right)^2 \right] - \frac{R^2}{3} m(\gamma_1 - \gamma_2) \frac{\cos^3 \phi_2 - \cos^3 \phi_1^2}{\sin^2 \phi_2} \quad (7)$$

SUBSTITUTING THE VALUE OF Q FROM P. III.2.3 INTO
 EQ. (5) P. III.2.6 GIVES:

$$N_{\phi_2} = -N_{\phi_2} + R \left\{ p_2 - p_1 + mR(\gamma_1 - \gamma_2)(\cos \phi_2 - \cos \phi_1^2) - mg_1(h_1 + h_2) \right\} \quad (8)$$

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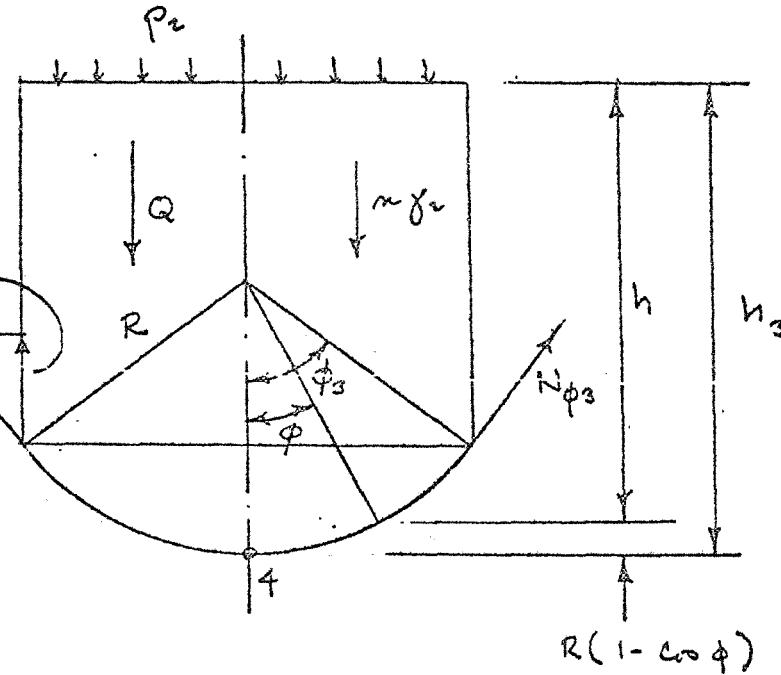
REGION

(4) (5)

N_{ϕ_3}

$N_{\phi_3} \sin \phi_3$

N_{ϕ_3}



AT DEPTH h , THE PRESSURE q IS:

$$q = p_2 + \gamma_2 h = p_2 + \gamma_2 \{h_3 - R(1 - \cos \phi)\}$$

FROM EQ. (1) P.III.2.3 THE VERTICAL LOADING IS GIVEN BY:

$$\begin{aligned} \frac{Q}{2\pi R^2} &= \int_0^{\phi_3} \{p_2 + \gamma_2(h_3 - R + R \cos \phi)\} \sin \phi \cos \phi d\phi \\ &= \int_0^{\phi_3} \{p_2 + \gamma_2(h_3 - R)\} \sin \phi \cos \phi d\phi \\ &\quad + \int_0^{\phi_3} \gamma_2 R \cos^2 \phi \sin \phi d\phi \end{aligned}$$

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$$\begin{aligned}
 \frac{Q}{2\pi R^2} &= \{ p_2 + \gamma_2 (h_3 - R) \} \left[\frac{\sin^2 \phi}{2} \right]_0^{\phi_3} \\
 &\quad - \gamma_2 R \left[\frac{\cos^3 \phi}{3} \right]_0^{\phi_3} \\
 &= \frac{1}{2} \{ p_2 + \gamma_2 (h_3 - R) \} \sin^2 \phi_3 - \\
 &\quad - \frac{1}{3} \gamma_2 R (\cos^3 \phi_3 - 1)
 \end{aligned}$$

FOR VERTICAL EQUILIBRIUM : (P. III.2.9)

$$N_{\phi_3} \sin \phi_3 \cdot 2\pi R \sin \phi_3 - Q = 0$$

SUBSTITUTING THE VALUE FOR Q :

$$\begin{aligned}
 2\pi R \sin^2 \phi_3 N_{\phi_3} &= 2\pi R^2 \left[\frac{1}{2} \{ p_2 + \gamma_2 (h_3 - R) \} \sin^2 \phi_3 - \right. \\
 &\quad \left. - \frac{1}{3} \gamma_2 R (\cos^3 \phi_3 - 1) \right]
 \end{aligned}$$

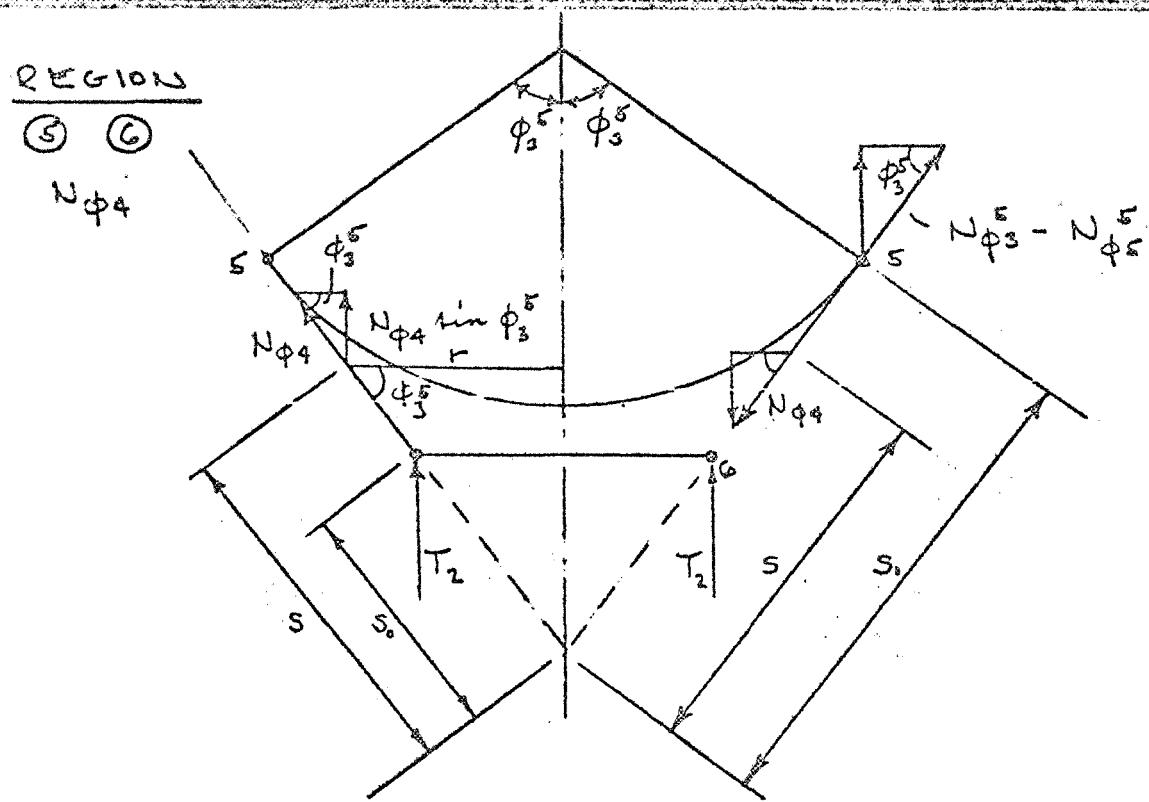
SOLVING FOR N_{ϕ_3} :

$$N_{\phi_3} = \frac{R}{2} \{ p_2 + \gamma_2 (h_3 - R) \} - \frac{R^2}{3} \gamma_2 \cdot \frac{\cos^3 \phi_3 - 1}{\sin^2 \phi_3} \quad (9)$$

SUBSTITUTING THE VALUE OF q FROM P. III.2.9 INTO
EQ. (5) P. III.2.6 GIVES :

$$N_{\phi_3} = -N_{\phi_3} + R \{ p_2 + \gamma_2 (h_3 - R + R \cos \phi_3) \} \quad (10)$$

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FIRST STAGE FIRING $T_1 \neq 0, T_2 = 0$

FOR THIS CASE, $N_{\phi 4} = N_{\theta 4} = 0$

SECOND STAGE FIRING. $T_1 = 0, T_2 \neq 0$

FOR THIS CASE, $N_{\phi 4}$ CAN BE COMPUTED
 FROM T_2 OR FROM $N_{\phi 3}^5 - N_{\phi 5}^5$ AT THE
 TOP EDGE.

a $N_{\phi 4}$ FROM T_2

FROM GEOMETRY $r = s \cos \phi_3^5$

FOR VERTICAL EQUILIBRIUM,

$$N_{\phi 4} \sin \phi_3^5 \cdot 2\pi s \cos \phi_3^5 + T_2 \cdot 2\pi s_0 \cos \phi_3^5 = 0$$

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SOLVING FOR $N_{\phi 4}$:

$$N_{\phi 4} = - \frac{S_0}{S} \cdot \frac{T_2}{\sin \phi_3^5}$$

(IIa)

THE EQUATION OF NORMAL EQUILIBRIUM OF A SMALL ELEMENT,

$$\frac{N_{\phi}}{r_1} + \frac{N_{\phi}}{r_2} = q \quad \text{FOR A CONE WHERE } r_1 \rightarrow \infty \Rightarrow r_2 = s \cot \phi_3^5$$

GIVES, FOR $q = 0$

$$N_{\phi 4} = 0$$

b $N_{\phi 4}$ FROM $N_{\phi 3}^5 - N_{\phi 5}^5$.

THIS IS THE TOP EDGE LOADING OF THE CONE DUE TO EDGE STRESSES IN THE SPHERICAL SECTION.

FROM P III.2.11, FOR VERTICAL EQUILIBRIUM;

$$N_{\phi 4} \sin \phi_3^5 \cdot 2\pi s \cos \phi_3^5 - (N_{\phi 3}^5 - N_{\phi 5}^5) \sin \phi_3^5 \cdot 2\pi s \cos \phi_3^5 = 0$$

SOLVING FOR $N_{\phi 4}$:

$$N_{\phi 4} = \frac{s_1}{S} \cdot (N_{\phi 3}^5 - N_{\phi 5}^5)$$

*

(IIb)

* USE VALUES OF $N_{\phi 3}$ AT POINT (5) FROM EQ. (9) P. III.2.10 AND $N_{\phi 5}$ AT POINT (5) FROM (19b) P. III.2.18

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REGION

(5) (3)

FIRST STAGE FIRING

$T_1 \neq 0, T_2 = 0$

$N_{\phi 5}$ FOR THIS CASE, THE EQUATIONS ARE
IDENTICAL TO EQ. (9) AND (10).

i.e;

$$N_{\phi 5} = \frac{R}{2} \left\{ p_2 + m g_2 (h_3 - R) \right\} - \frac{R^2}{3} m g_2 \cdot \frac{\cos^3 \phi_3 - 1}{\sin^2 \phi_3} \quad (12)$$

$$N_{\phi 5} = -N_{\phi 5} + R \left\{ p_2 + m g_2 (h_3 - R + R \cos \phi_3) \right\} \quad (13)$$

SECOND STAGE FIRING $T_1 = 0, T_2 \neq 0$

FOR THIS CASE, $N_{\phi 5}$ CAN BE COMPUTED
FROM $N_{\phi 4}^5$ (AS A FUNCTION OF T_2) AND
 $N_{\phi 3}^5$ AT THE BOTTOM EDGE OR FROM
 $N_{\phi 2}^3$ AND $N_{\phi 6}^3$ AT THE TOP EDGE,
(THE USE OF TOP OR BOTTOM EDGE LOADING
TO COMPUTE INTERNAL FORCES IS ANALOGOUS
TO THE USE OF REACTIONS AT THE LEFT
OR AT THE RIGHT FOR COMPUTING INTERNAL
FORCES ON A SIMPLE BEAM.)

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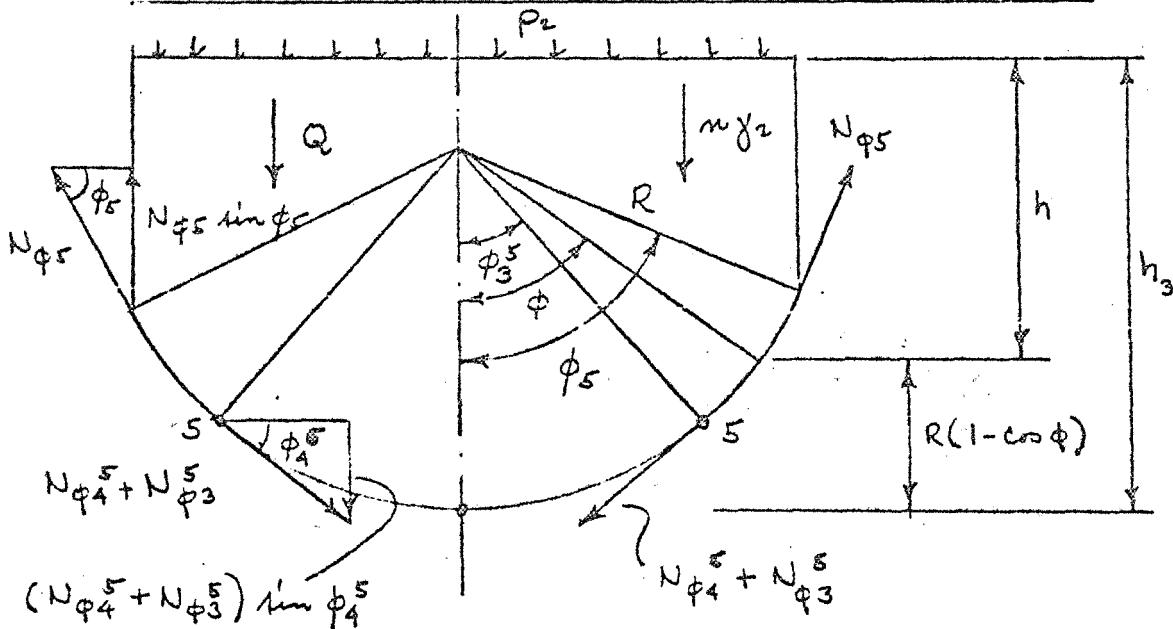
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DIVISION

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a) N_{ϕ^5} AS A FUNCTION OF N_{ϕ^4} AND N_{ϕ^3} .



AT DEPTH, h , THE PRESSURE, q , IS GIVEN BY

$$q = p_2 + \gamma_2 h = p_2 + \gamma_2 (h_3 - R + R \cos \phi)$$

SUBSTITUTING THIS VALUE INTO EQ. (1) P III.2.3

$$\begin{aligned} \frac{Q}{2\pi R^2} &= \int_{\phi_3^5}^{\phi_5} \{p_2 + \gamma_2(h_3 - R + R \cos \phi)\} \sin \phi \cos \phi d\phi \\ &= \int_{\phi_3^5}^{\phi_5} \{p_2 + \gamma_2(h_3 - R)\} \sin \phi \cos \phi d\phi \\ &\quad + \int_{\phi_3^5}^{\phi_5} \gamma_2 R \cos^2 \phi \sin \phi d\phi. \end{aligned}$$

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$$\begin{aligned}
 \frac{Q}{2\pi R^2} &= \left\{ p_2 + \gamma_2 (h_3 - R) \right\} \left[\frac{\sin^2 \phi}{2} \right] \frac{\phi_5^5}{\phi_3^5} \\
 &\quad - \gamma_2 R \left[\frac{\cos^3 \phi}{3} \right] \frac{\phi_5^5}{\phi_3^5} \\
 &= \frac{1}{2} \left\{ p_2 + \gamma_2 (h_3 - R) \right\} (\sin^2 \phi_5 - \sin^2 \phi_3^5) \\
 &\quad - \frac{\gamma_2 R}{3} (\cos^3 \phi_5 - \cos^3 \phi_3^5)
 \end{aligned}$$

THE EQUATION OF VERTICAL EQUILIBRIUM IS:

$$N_{\phi_5} \sin \phi_5 \cdot 2\pi R \sin \phi_5 - (N_{\phi_4}^5 + N_{\phi_3}^5) \sin \phi_3^5 \cdot 2\pi R \sin \phi_3^5 - Q = 0$$

SUBSTITUTING THE VALUE OF Q:

$$\begin{aligned}
 2\pi R \sin^2 \phi_5 N_{\phi_5} - 2\pi R \sin^2 \phi_3^5 (N_{\phi_4}^5 + N_{\phi_3}^5) - \\
 - 2\pi R^2 \left[\frac{1}{2} \left\{ p_2 + \gamma_2 (h_3 - R) \right\} (\sin^2 \phi_5 - \sin^2 \phi_3^5) \right. \\
 \left. - \frac{\gamma_2 R}{3} (\cos^3 \phi_5 - \cos^3 \phi_3^5) \right] = 0
 \end{aligned}$$

SOLVING FOR N_{ϕ_5} :

$$\begin{aligned}
 N_{\phi_5} &= (N_{\phi_4}^5 + N_{\phi_3}^5) \left(\frac{\sin \phi_3^5}{\sin \phi_5} \right)^2 + \frac{R}{2} \left\{ p_2 + \gamma_2 (h_3 - R) \right\} \left\{ 1 - \left(\frac{\sin \phi_3^5}{\sin \phi_5} \right)^2 \right. \\
 &\quad \left. - \frac{R^2}{3} \gamma_2 \cdot \frac{\cos^3 \phi_5 - \cos^3 \phi_3^5}{\sin^2 \phi_5} \right\} \\
 &\quad *
 \end{aligned}$$

* USE VALUES OF N_{ϕ_4} AT POINT ⑤ FROM EQ. (11a) p. III. 2.12 — (14a)
 AND N_{ϕ_3} AT POINT ③ FROM EQ. (9) p. III. 2.10

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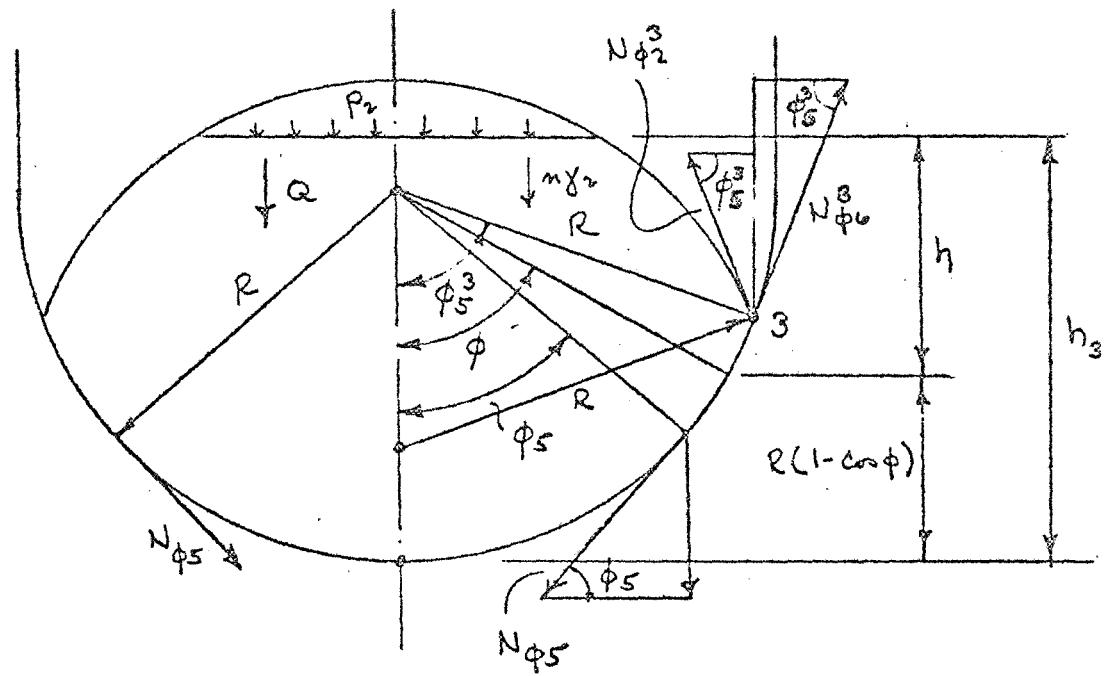
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FROM EQ. (5) p. III.2.5 USING THE VALUE OF q :

$$N_{\phi 5} = -N_{\phi 5} + R \{ p_2 + n \gamma_2 (h_3 - R + R \cos \phi) \} \quad (15)$$

b) $N_{\phi 5}$ AS A FUNCTION OF $N_{\phi 2}^3$ AND $N_{\phi 6}^3$



AT DEPTH, h , THE PRESSURE IS GIVEN BY:

$$q = p_2 + n \gamma_2 h = p_2 + n \gamma_2 (h_3 - R + R \cos \phi)$$

SUBSTITUTING THIS VALUE INTO EQ. (1) p. III.2.3

$$\frac{Q}{2\pi R^2} = \int_{\phi_5}^{\phi_5^3} \{ p_2 + n \gamma_2 (h_3 - R + R \cos \phi) \} \sin \phi \cos \phi d\phi$$

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$$\begin{aligned}
 \frac{Q}{2\pi R^2} &= \int_{\phi_5}^{\phi_6} \{p_2 + n\gamma_2(h_3 - R)\} \sin \phi \cos \phi d\phi \\
 &\quad + \int_{\phi_5}^{\phi_6} n\gamma_2 R \cos^2 \phi \sin \phi d\phi \\
 &= \{p_2 + n\gamma_2(h_3 - R)\} \left[\frac{\sin^2 \phi}{2} \right]_{\phi_5}^{\phi_6} \\
 &\quad - n\gamma_2 R \left[\frac{\cos^3 \phi}{3} \right]_{\phi_5}^{\phi_6} \\
 &= \frac{1}{2} \{p_2 + n\gamma_2(h_3 - R)\} (\sin^2 \phi_6 - \sin^2 \phi_5) \\
 &\quad - \frac{1}{3} n\gamma_2 R (\cos^3 \phi_6 - \cos^3 \phi_5)
 \end{aligned}$$

THE EQUATION OF VERTICAL EQUILIBRIUM IS:

$$N_{\phi_5} \sin \phi_5 \cdot 2\pi R \sin \phi_5 - (N_{\phi_2}^3 + N_{\phi_6}^3) \sin \phi_5^3 \cdot 2\pi R \sin \phi_5 + Q = 0$$

SUBSTITUTING FOR Q:

$$\begin{aligned}
 2\pi R \sin^2 \phi_5 N_{\phi_5} - 2\pi R \sin^2 \phi_5^3 (N_{\phi_2}^3 + N_{\phi_6}^3) \\
 + 2\pi R^2 \left[\frac{1}{2} \{p_2 + n\gamma_2(h_3 - R)\} (\sin^2 \phi_6 - \sin^2 \phi_5) \right. \\
 \left. - \frac{1}{3} n\gamma_2 R (\cos^3 \phi_6 - \cos^3 \phi_5) \right] = 0
 \end{aligned}$$

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PAGE THE 2, 18MODEL DSV-4REPORT NO. SM 42569SOLVING FOR N_{ϕ_5} :

$$N_{\phi_5} = (N_{\phi_2}^3 + N_{\phi_6}^3) \left(\frac{\sin \phi_5^3}{\sin \phi_5} \right)^2 - \frac{R}{2} \left\{ p_2 + m g_2 (h_3 - e) \right\} \left\{ \left(\frac{\sin \phi_5^3}{\sin \phi_5} \right)^2 - 1 \right\} \\ + \frac{R^2}{3} m g_2 \cdot \frac{\cos^3 \phi_5^3 - \cos^3 \phi_5}{\sin^2 \phi_5}$$

* USE VALUES OF N_{ϕ_2} AT POINT (3) FROM EQ. (7) p III. 2.8
 AND N_{ϕ_6} AT POINT (3) FROM EQ. (17) p. III. 2.22

— (14b)

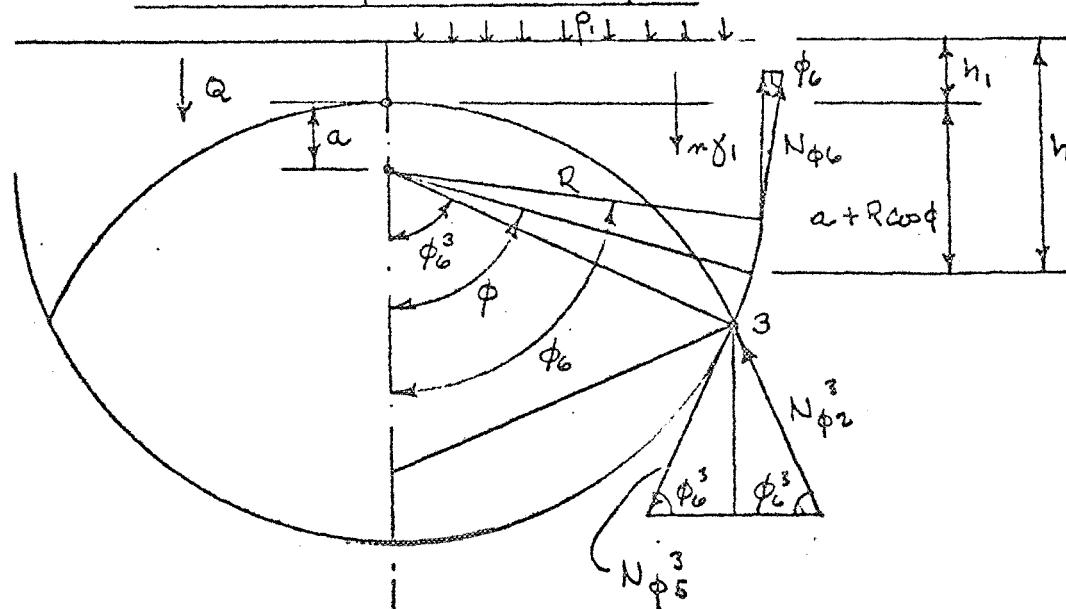
N_{ϕ_5} IS GIVEN, AS BEFORE, BY EQ. (15). p III. 2.16

REGIONFIRST STAGE FIRING

(3) (7)

N_{ϕ_6} MAY BE OBTAINED FROM $N_{\phi_5}^3$ FROM
 EQ. (12) p. III. 2.13 AND $N_{\phi_2}^3$ EQ. (7) p. III. 2.8
 OR FROM T_1 .

a)

FROM $N_{\phi_5}^3$ AND $N_{\phi_2}^3$ 

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FROM P III.2.18 AT DEPTH, h , THE PRESSURE
 IS GIVEN BY:

$$q = p_i + \gamma g_i h = p_i + \gamma g_i (h_i + a + R \cos \phi)$$

SUBSTITUTING INTO EQ. (1) P. III.2.3 FOR THE
 VERTICAL LOAD, Q :

$$\begin{aligned} \frac{Q}{2\pi R^2} &= \int_{\phi_6^3}^{\phi_6} \{p_i + \gamma g_i(h_i + a + R \cos \phi)\} \sin \phi \cos \phi d\phi \\ &= \int_{\phi_6^3}^{\phi_6} \{p_i + \gamma g_i(h_i + a)\} \sin \phi \cos \phi d\phi + \int_{\phi_6^3}^{\phi_6} \gamma g_i R \cos^2 \phi \sin \phi d\phi \\ &= [p_i + \gamma g_i(h_i + a)] \left[\frac{\sin^2 \phi}{2} \right]_{\phi_6^3}^{\phi_6} - \gamma g_i R \left[\frac{\cos^3 \phi}{3} \right]_{\phi_6^3}^{\phi_6} \\ &= \frac{1}{2} [p_i + \gamma g_i(h_i + a)] (\sin^2 \phi_6 - \sin^2 \phi_6^3) \\ &\quad - \frac{1}{3} \gamma g_i R (\cos^3 \phi_6 - \cos^3 \phi_6^3) \end{aligned}$$

FOR VERTICAL EQUILIBRIUM:

$$N_{\phi_6} \sin \phi_6 \cdot 2\pi R \sin \phi_6 + (N_{\phi_6}^3 - N_{\phi_5}^3) \sin \phi_6^3 \cdot 2\pi R \sin \phi_6^3 - Q = 0$$

SUBSTITUTING FOR Q :

$$\begin{aligned} 2\pi R \sin^2 \phi_6 N_{\phi_6} + 2\pi R \sin^2 \phi_6^3 (N_{\phi_6}^3 - N_{\phi_5}^3) - \\ - 2\pi R^2 \left\{ \frac{1}{2} [p_i + \gamma g_i(h_i + a)] (\sin^2 \phi_6 - \sin^2 \phi_6^3) - \frac{1}{3} \gamma g_i R (\cos^3 \phi_6 - \cos^3 \phi_6^3) \right\} \\ = 0 \end{aligned}$$

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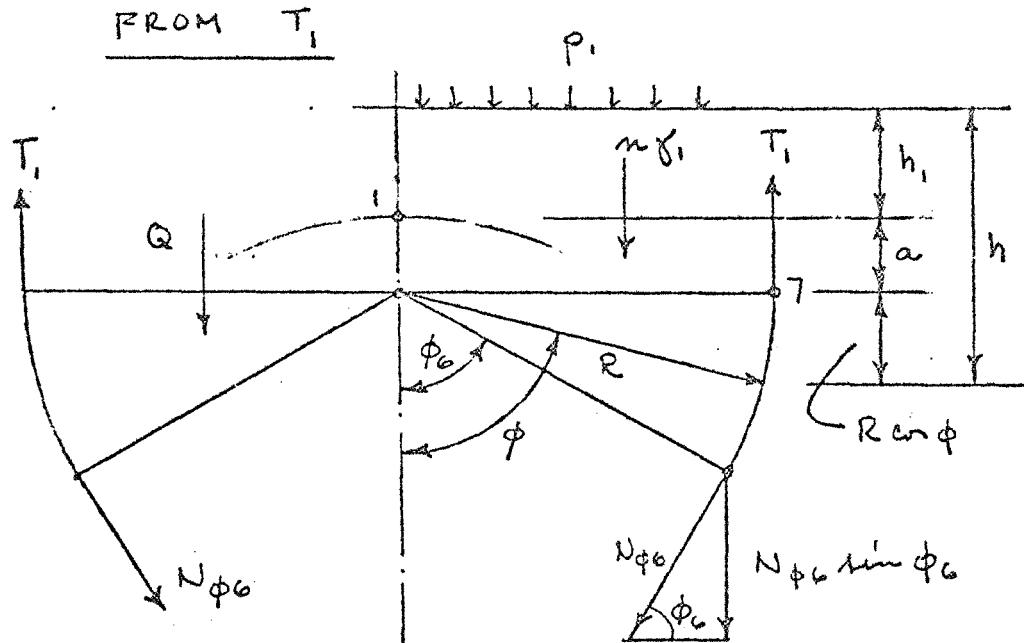
SOLVING FOR N_{ϕ_6} :

$$N_{\phi_6} = (N_{\phi_5}^3 - N_{\phi_2}^3) \left(\frac{\sin \phi_6^3}{\sin \phi_6} \right)^2 + R \left[p_1 + n \gamma_1 (h_1 + a) \right] \left\{ 1 - \left(\frac{\sin \phi_6^3}{\sin \phi_6} \right)^2 \right\} - \frac{R^2}{3} n \gamma_1 \cdot \frac{\cos^3 \phi_6 - \cos^3 \phi_5^3}{\sin^2 \phi_6} *$$

FROM EQ. (5) p. III.2.5 N_{ϕ} IS GIVEN BY ————— (15a)

$$N_{\phi_6} = -N_{\phi_6} + R \{ p_1 + n \gamma_1 (h_1 + a + R \cos \phi_6) \} ————— (16)$$

b)



AT DEPTH, h , THE PRESSURE IS GIVEN BY:

$$q = p_1 + n \gamma_1 h = p_1 + n \gamma_1 (h_1 + a + R \cos \phi)$$

* USE VALUES OF N_{ϕ_5} AT POINT ③ FROM EQ. (12) p. III.2.13
 AND N_{ϕ_2} AT POINT ③ FROM EQ. (7) p. III.2.8

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THE VERTICAL COMPONENT OF LOAD, BY EQ.(1)

P.III.2.3 IS GIVEN BY:

$$\begin{aligned} \frac{Q}{2\pi R^2} &= \int_{\phi_0}^{\pi/2} \{ p_i + m g_i (h_i + a + R \cos \phi) \} \sin \phi \cos \phi d\phi \\ &= \int_{\phi_0}^{\pi/2} \{ p_i + m g_i (h_i + a) \} \sin \phi \cos \phi + \int_{\phi_0}^{\pi/2} m g_i R \cos^2 \phi \sin \phi d\phi \\ &= \{ p_i + m g_i (h_i + a) \} \left[\frac{\sin^2 \phi}{2} \right]_{\phi_0}^{\pi/2} - m g_i R \left[\frac{\cos^3 \phi}{3} \right]_{\phi_0}^{\pi/2} \\ &= \frac{1}{2} \{ p_i + m g_i (h_i + a) \} (1 - \sin^2 \phi_0) + \frac{1}{3} m g_i R \cos^3 \phi_0 \end{aligned}$$

FOR VERTICAL EQUILIBRIUM:

$$N_{\phi_0} \sin \phi_0 \cdot 2\pi R \sin \phi_0 - T_i \cdot 2\pi R + Q = 0$$

SUBSTITUTING FOR Q:

$$\begin{aligned} 2\pi R \sin^2 \phi_0 N_{\phi_0} - T_i \cdot 2\pi R + 2\pi R^2 \left[\frac{1}{2} \{ p_i + m g_i (h_i + a) \} (1 - \sin^2 \phi_0) \right. \\ \left. + \frac{1}{3} m g_i R \cos^3 \phi_0 \right] = 0 \end{aligned}$$

SOLVING FOR N_{ϕ_0} :

$$\begin{aligned} N_{\phi_0} &= \frac{T_i}{\sin^2 \phi_0} - \frac{R}{2} \left\{ p_i + m g_i (h_i + a) \right\} \left[\frac{1 - \sin^2 \phi_0}{\sin^2 \phi_0} \right] - \\ &\quad - \frac{R^2}{3} m g_i \frac{\cos^3 \phi_0}{\sin^2 \phi_0} \end{aligned} \tag{15b}$$

AND N_{ϕ_0} IS GIVEN BY EQ. (16) p III.2.20

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SECOND STAGE FIRING

THIS LOAD CONDITION ON REGION (3)-⑦ IS
OBTAINED FROM SOLUTION (15b) FOR $T_1 = \frac{p_1 R}{2}$
i.e.

$$N_{\phi 0} = \frac{p_1 R}{2} - \frac{\gamma g x_1 R}{G} \left\{ 3(h_1 + a) + 2R \cos \phi_0 \right\} \left(\frac{\cos \phi_0}{\sin \phi_0} \right)^2 \quad (17)$$

N_θ IS GIVEN BY EQ (16) p. III, 2.20

i.e.

$$N_{\theta 0} = -N_{\phi 0} + R \left\{ p_1 + \gamma g_1 (h_1 + a + R \cos \phi_0) \right\} \quad (18)$$

PREPARED BY: E.P.N. V.R.
CHECKED BY: J.D.H. 8/1/60
DATE: 8-1-60
TITLE: DSV-4 PROPELLANT TANK

EQUATIONS OF MOTION CONTINUATION, 1960

SM

DIVISION

PAGE III, 2-23

MODEL: DSV-4

REPORT NO. SH 4256 9

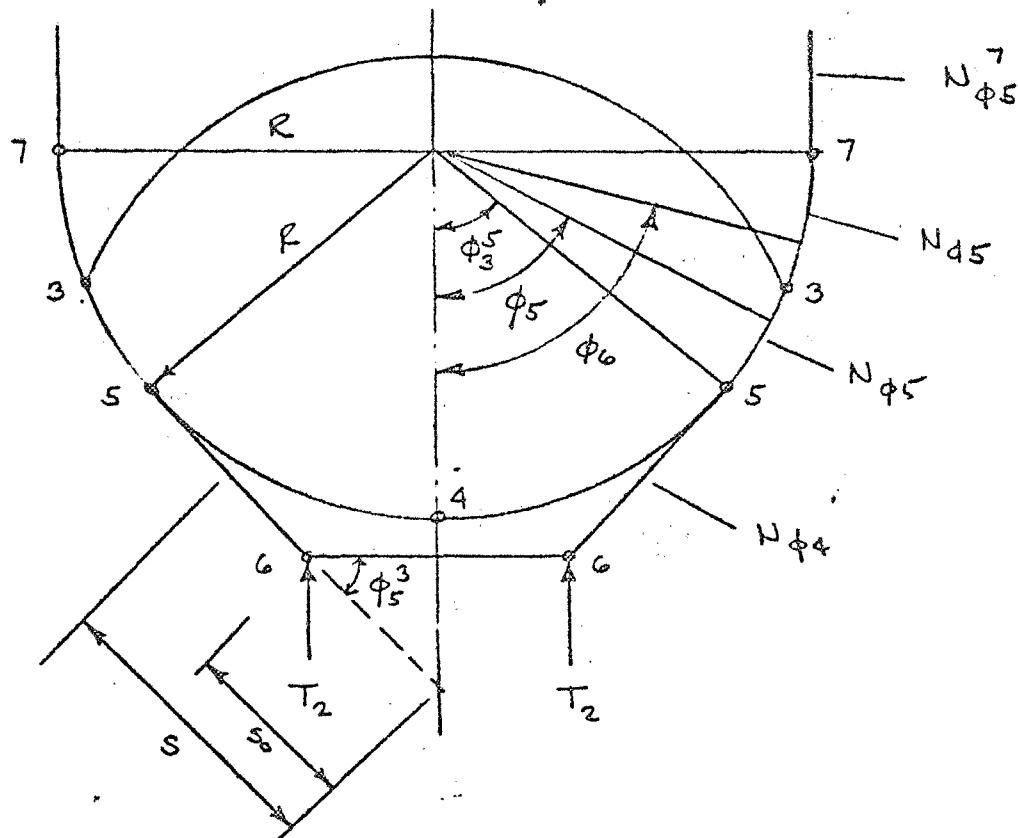
TO COMPLETE THE PROBLEM, STRESSES DUE TO GRAVITY AND ACCELERATION OF THE THIRD STAGE WILL NOW BE CONSIDERED.

FIRST STAGE FIRING

FOR THIS CONDITION, THE LOADS WILL PASS DIRECTLY THROUGH THE OUTER CYLINDRICAL SHELL (I.E., POINT ⑦)

SECOND STAGE FIRING

FOR THIS CONDITION, THE LOAD PATH WILL BE THROUGH POINTS ④ ⑥ ③ AND ⑦.



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PAGE III.2.24

MODEL: DSV-4

REPORT NO. S114756

REGION ⑥-⑦

THIS IS GIVEN BY EQ. (11a) p. III.2.13

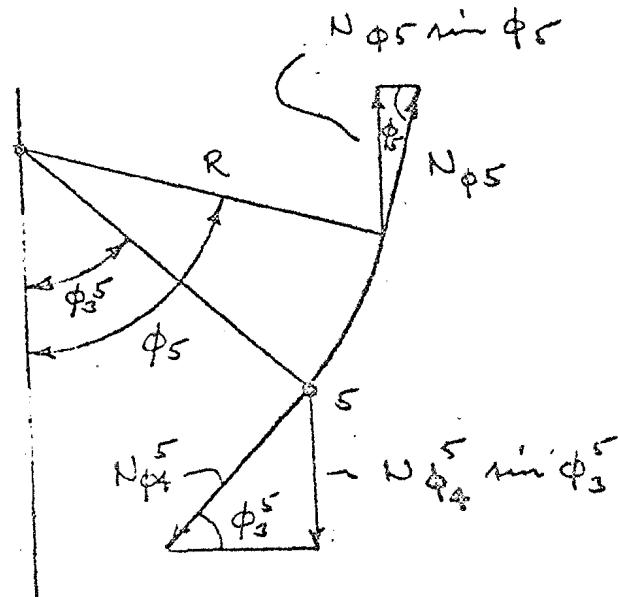
$$N_{\phi 4} = 0$$

$$N_{\phi 4} = - \frac{s_0}{s} \cdot \frac{T_2}{\sin \phi_3^5} \quad (19)$$

$$\text{AND } N_{\theta 4} = 0$$

REGION ⑤-⑦

$$N_{\phi 5}$$



FOR VERTICAL EQUILIBRIUM:

$$N_{\phi 5} \sin \phi_5 \cdot 2\pi R \sin \phi_5 - N_{\phi 4} \sin \phi_3^5 \cdot 2\pi R \sin \phi_3^5 = 0$$

SOLVING FOR $N_{\phi 5}$:

$$N_{\phi 5} = N_{\phi 4} \left(\frac{\sin \phi_3^5}{\sin \phi_5} \right)^2 \quad (20)$$

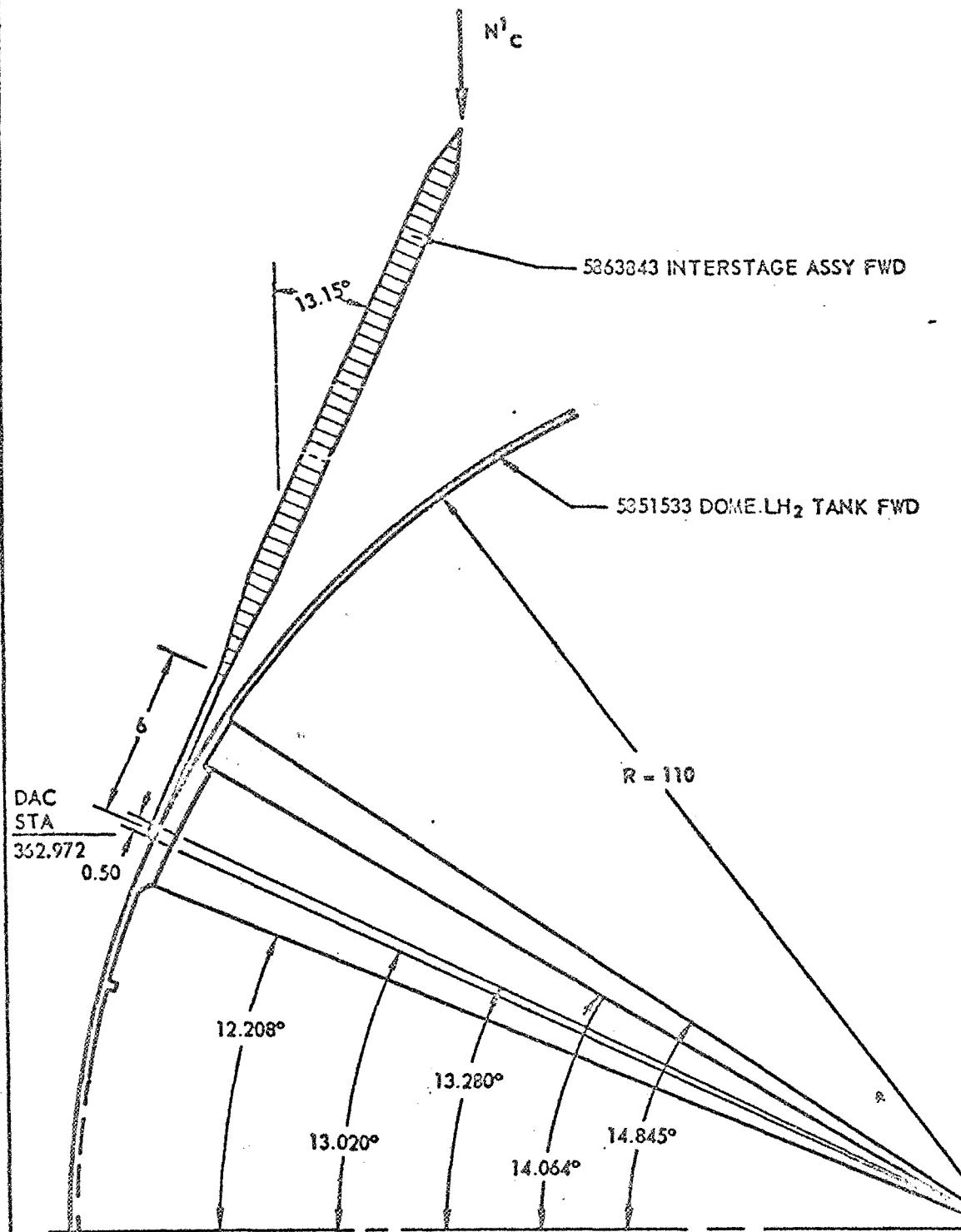
FROM EQ. (5) p. III.2.5

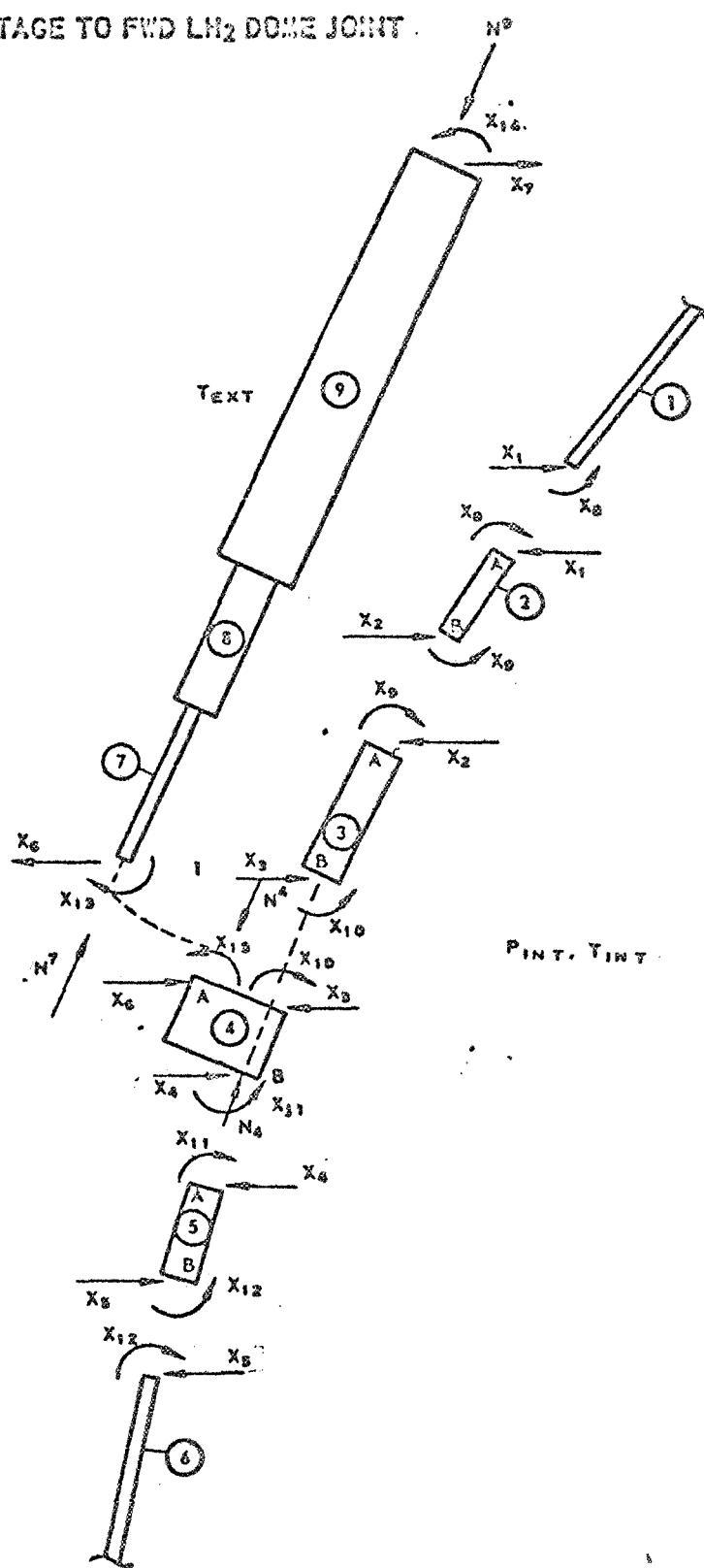
$$N_{\theta 5} = -N_{\phi 5} \quad (21)$$

The following sections of Appendix III contain the general relative deflection equations used throughout this report. A description of the nomenclature is given on Page III.0.0.

The general equations are for:

Forward Interstage to Forward Dome, Joint	III.3.0.1
Forward Dome to Tank, Joint	III.4.0
Aft Skirt to Aft Dome, Joint	III.5.0
Cannon Bulkhead to Aft Dome, Joint	III.6.0
Thrust Structure to Aft Dome, Joint	III.7.0
LH ₂ Tank Door Installation	III.8.0

FWD INTERSTAGE TO FWD LH₂ DOME JOINT

FWD INTERSTAGE TO FWD LH₂ DOME JOINT

PREPARED BY: G. J. S.
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PACK III, 3, P

MODEL DSV-4

REPORT NO. SM 42569

PART 15863800. STRUCT
ASSY

$$\delta'_{1,1} = \frac{x_1}{E_1 I_1} (\theta R \sin^2 \phi') (K_2 + \frac{L}{K_1})$$

$$\delta'_{1,8} = \frac{x_8}{E_1 I_1} \left(\frac{2 B^2 \sin \phi'^2}{K_1} \right)$$

$$\delta'_{1,T} = -\infty, \Delta T_m R \sin \phi'^2$$

$$\delta'_{1,P} = -\frac{P_m R^2}{2 E_1 I_1} (1-v) \sin \phi'^2$$

$$\delta'_{8,1} = \delta'_{1,8}$$

$$\delta'_{8,8} = \frac{x_8}{E_1 I_1} \left(\frac{4 B^3}{R K_1} \right)$$

$$\delta'_{8,P} = 0$$

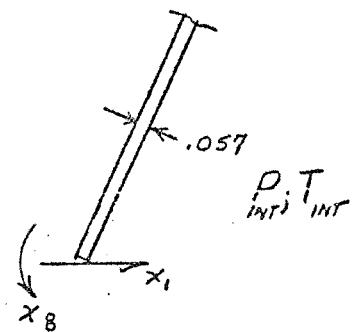
$$\delta'_{8,T} = 0$$

$$\phi'^2 = 90^\circ - 14.845^\circ = \phi'^2 = 75.155^\circ$$

$$\theta = \sqrt{3(1-v^2)} \left(\frac{R}{x_1} \right)^2$$

$$K_1 = 1 - \frac{1-2v}{2B} \cot \phi'^2$$

$$K_2 = 1 - \frac{1+2v}{2B} \cot \phi'^2$$



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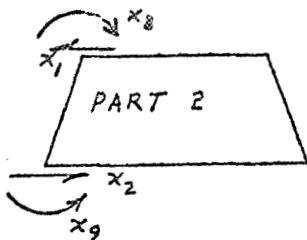
PAGE III, 3, 3

MODEL DSV-4

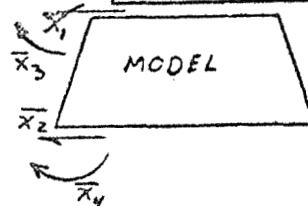
REPORT NO. SM 42569

PART 2

$$\begin{aligned}x_1 &= \bar{x}_1 \\x_2 &= -\bar{x}_2 \\x_3 &= \bar{x}_3 \\x_4 &= -\bar{x}_4\end{aligned}$$



5863800 STRUCTURE ASSY



$$S_{1,1} = + + = + \bar{\delta}_{1,1}$$

$$S_{1,2} = + - = - \bar{\delta}_{1,2}$$

$$S_{1,3} = + + = + \bar{\delta}_{1,3}$$

$$S_{1,4} = + - = - \bar{\delta}_{1,4}$$

$$S_{1,P} = \frac{P_{nr} R^2 (1-v)}{2 E_2 I_2} \sin \phi^{1,2}$$

$$S_{1,T} = \alpha \Delta T_{nr} R \sin \phi^{1,2}$$

$$S_{2,1} = - + = - \bar{\delta}_{2,1}$$

$$S_{2,2} = - - = + \bar{\delta}_{2,2}$$

$$S_{2,3} = - + = - \bar{\delta}_{2,3}$$

$$S_{2,4} = - - = + \bar{\delta}_{2,4}$$

$$S_{2,P} = - \frac{P_{nr} R^2 (1-v)}{2 E_2 I_2} \sin \phi^{2,3}$$

$$S_{2,T} = - \alpha \Delta T_{nr} R \sin \phi^{2,3}$$

$$S_{3,1} = + + = + \bar{\delta}_{3,1}$$

$$S_{3,2} = + - = - \bar{\delta}_{3,2}$$

$$S_{3,3} = + + = + \bar{\delta}_{3,3}$$

$$S_{3,4} = + - = - \bar{\delta}_{3,4}$$

$$S_{3,P} = 0$$

$$S_{3,T} = 0$$

$$S_{4,1} = - + = - \bar{\delta}_{4,1}$$

$$S_{4,2} = - - = + \bar{\delta}_{4,2}$$

$$S_{4,3} = - + = - \bar{\delta}_{4,3}$$

$$S_{4,4} = - - = + \bar{\delta}_{4,4}$$

$$S_{4,P} = 0$$

$$S_{4,T} = 0$$

$$\phi^{1,2} = 90^\circ - 14.845^\circ = \phi^{1,2} = 75.155^\circ$$

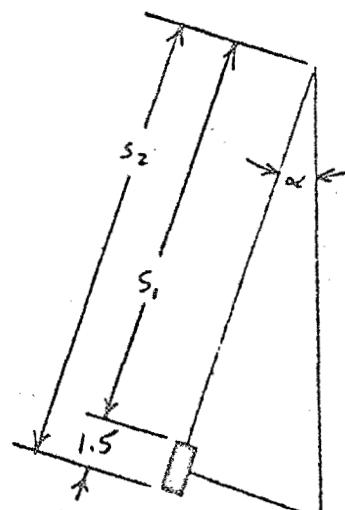
$$\phi^{2,3} = 90^\circ - 14.064^\circ = \phi^{2,3} = 75.936^\circ$$

$$I_2 = .125''$$

$$\alpha = 14.454^\circ$$

$$S_1 = \frac{110}{\tan 14.454^\circ} - .625 = S_1 = 426.244$$

$$S_2 = \frac{110}{\tan 14.454^\circ} + .625 = S_2 = 427.494$$



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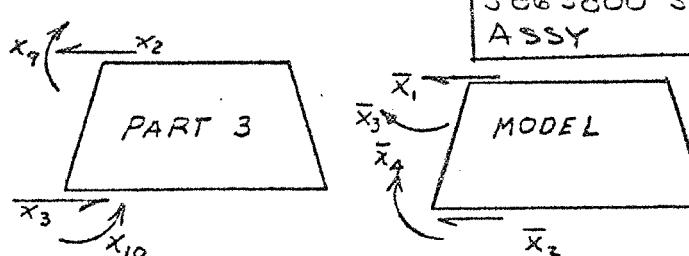
DIVISION

PAGE: III, 3, 4
MODEL: DSV-4

REPORT NO.: A42569

PART 3

$$\begin{aligned}x_2 &= \bar{x}_1 \\x_3 &= -\bar{x}_2 \\x_9 &= \bar{x}_3 \\x_{10} &= -\bar{x}_4\end{aligned}$$



$$\begin{aligned}\delta_{2,2} &= + + = \bar{\delta}_{1,1} \\ \delta_{2,3} &= + - = -\bar{\delta}_{1,2} \\ \delta_{2,4} &= + + = +\bar{\delta}_{1,3} \\ \delta_{2,10} &= + - = -\bar{\delta}_{1,4} \\ \delta_{2,P} &= \frac{P_m R^2 (1-\nu) \sin \phi^{2,3}}{2 E_3 \mathcal{X}_3}\end{aligned}$$

$$\delta_{2,T} = \alpha \Delta T_m R \sin \phi^{2,3}$$

$$\begin{aligned}\delta_{3,2} &= - + = -\bar{\delta}_{2,1} \\ \delta_{3,3} &= - - = +\bar{\delta}_{2,2} \\ \delta_{3,9} &= - + = -\bar{\delta}_{2,3} \\ \delta_{3,10} &= - - = +\bar{\delta}_{2,4} \\ \delta_{3,P} &= - \frac{P_m R^2 (1-\nu) \sin \phi^{3,4}}{2 E_3 \mathcal{X}_3} \\ \delta_{3,T} &= - \alpha \Delta T_m R \sin \phi^{3,4}\end{aligned}$$

$$\begin{aligned}\delta_{9,2} &= + + = +\bar{\delta}_{3,1} \\ \delta_{9,3} &= + - = -\bar{\delta}_{3,2} \\ \delta_{9,9} &= + + = +\bar{\delta}_{3,3} \\ \delta_{9,10} &= + - = -\bar{\delta}_{3,4} \\ \delta_{9,P} &= 0 \\ \delta_{9,T} &= 0\end{aligned}$$

$$\begin{aligned}\delta_{10,2} &= - + = -\bar{\delta}_{4,1} \\ \delta_{10,3} &= - - = +\bar{\delta}_{4,2} \\ \delta_{10,9} &= - + = -\bar{\delta}_{4,3} \\ \delta_{10,10} &= - - = +\bar{\delta}_{4,4} \\ \delta_{10,P} &= 0 \\ \delta_{10,T} &= 0\end{aligned}$$

$$\phi^{2,3} = 74.376^\circ$$

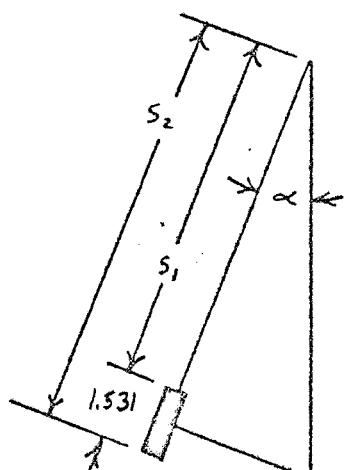
$$\phi^{3,4} = 90^\circ - 13.280 = \phi^{3,4} = 76.720^\circ$$

$$\mathcal{X}_3 = .250$$

$$\alpha = 13.672^\circ$$

$$S_1 = \frac{110}{\tan 13.672^\circ} - .766 = S_1 = 451.611$$

$$S_2 = \frac{110}{\tan 13.672^\circ} + .766 = S_2 = 453.143$$



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DATE: 1-11-61

TITLE: PSV-1 PROPELLANT TANK

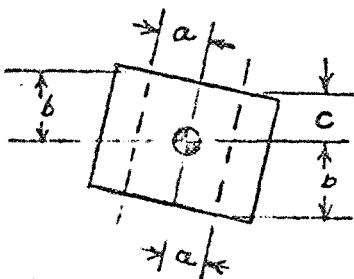
SM

DIVISION

PAGE: III. 3, 5

MODEL: DSV-1

REPORT NO.: S 114256 C

PART 4

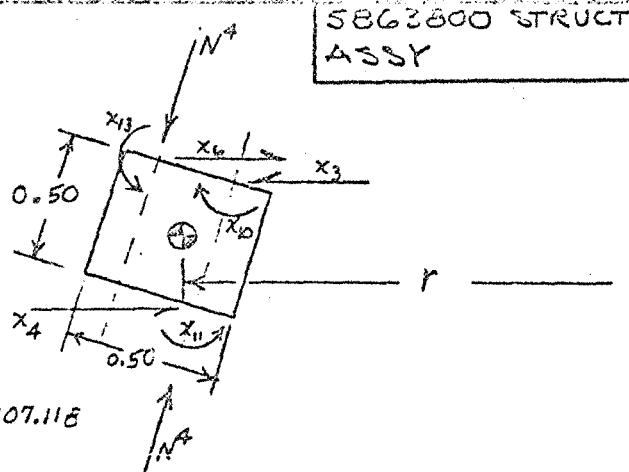
$$\alpha = 0.125$$

$$r = 110 \text{ rad} \cdot 13.15^\circ = r = 107.118$$

$$b = 0.275$$

$$c = 0.224$$

$$I_4 = \frac{(1.5)^2}{12} [(.5)^2 \cos^2 76.85 + (.5)^2 \sin^2 76.85] = I_4 = .0052 \text{ IN}^4$$



$$\delta_{3,3} = \frac{x_3 r^2}{E_4 A_4} + \frac{x_3 c^2 r^2}{E_4 I_4}$$

$$\delta_{3,4} = -\frac{x_4 r^2}{E_4 A_4} + \frac{x_4 b c r^2}{E_4 I_4}$$

$$\delta_{3,6} = -\frac{x_6 r^2}{E_4 A_4} - \frac{x_6 b c r^2}{E_4 I_4}$$

$$\delta_{3,10} = -\frac{x_{10} c r^2}{E_4 I_4}$$

$$\delta_{3,11} = \frac{x_{11} c r^2}{E_4 I_4}$$

$$\delta_{3,13} = \frac{x_{13} c r^2}{E_4 I_4}$$

$$\delta_{3,N^4} = \frac{2 N^4 \alpha c r^2}{E_4 I_4}$$

$$\delta_{3,T} = \alpha \Delta T_w r$$

$$\delta_{3,P} = 0$$

$$\delta_{4,3} = \delta_{3,4}$$

$$\delta_{4,4} = \frac{x_4 r^2}{E_4 A_4} + \frac{x_4 b^2 r^2}{E_4 I_4}$$

$$\delta_{4,6} = \frac{x_6 r^2}{E_4 A_4} - \frac{x_6 b^2 r^2}{E_4 I_4}$$

$$\delta_{4,10} = -\frac{x_{10} b r^2}{E_4 I_4}$$

$$\delta_{4,11} = \frac{x_{11} b r^2}{E_4 I_4}$$

$$\delta_{4,13} = \frac{x_{13} b r^2}{E_4 I_4}$$

$$\delta_{4,N^4} = \frac{2 N^4 \alpha b r^2}{E_4 I_4}$$

$$\delta_{4,T} = -\alpha \Delta T_w r$$

$$\delta_{4,P} = 0$$

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 CHECKED BY G. R. H.
 DATE 1-11-61

DOUGLAS AIRCRAFT COMPANY, INC.

SM

DIVISION

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MODEL DSV-4

REPORT NO. SN 42569

TITLE: DSV-4 PROPELLANT TANK

$$\delta_{6,3} = \delta_{3,6}$$

$$\delta_{6,4} = \delta_{4,6}$$

$$\delta_{6,6} = \frac{x_6 r^2}{E_4 I_4} + \frac{x_6 b^2 r^2}{E_4 I_4}$$

$$\delta_{6,10} = \frac{x_{10} b r^2}{E_4 I_4}$$

$$\delta_{6,11} = -\frac{x_{11} b r^2}{E_4 I_4}$$

$$\delta_{6,13} = -\frac{x_{13} b r^2}{E_4 I_4}$$

$$\delta_{6,N^4} = -\frac{2N^4 \alpha b k^2}{E_4 I_4}$$

$$\delta_{6,T} = -\alpha \Delta T_m r$$

$$\delta_{6,P} = 0$$

$$\delta_{11,3} = \delta_{3,11}$$

$$\delta_{11,4} = \delta_{4,11}$$

$$\delta_{11,6} = \delta_{6,11}$$

$$\delta_{11,10} = \delta_{10,11}$$

$$\delta_{11,11} = \frac{x_{11} r^2}{E_4 I_4}$$

$$\delta_{11,13} = \frac{x_{13} r^2}{E_4 I_4}$$

$$\delta_{11,N^4} = \frac{2N^4 \alpha r^2}{E_4 I_4}$$

$$\delta_{11,T} = 0$$

$$\delta_{11,P} = 0$$

SB63800 STRUCTURE
ASSY

$$\delta_{10,3} = \delta_{3,10}$$

$$\delta_{10,4} = \delta_{4,10}$$

$$\delta_{10,6} = \delta_{6,10}$$

$$\delta_{10,10} = \frac{x_{10} r^2}{E_4 I_4}$$

$$\delta_{10,11} = -\frac{x_{11} r^2}{E_4 I_4}$$

$$\delta_{10,13} = -\frac{x_{13} r^2}{E_4 I_4}$$

$$\delta_{10,N^4} = -\frac{2N^4 \alpha r^2}{E_4 I_4}$$

$$\delta_{10,T} = 0$$

$$\delta_{10,P} = 0$$

$$\delta_{13,3} = \delta_{3,13}$$

$$\delta_{13,4} = \delta_{4,13}$$

$$\delta_{13,6} = \delta_{6,13}$$

$$\delta_{13,10} = \delta_{10,13}$$

$$\delta_{13,11} = \delta_{11,13}$$

$$\delta_{13,13} = \frac{x_{13} r^2}{E_4 I_4}$$

$$\delta_{13,N^4} = \frac{2N^4 \alpha r^2}{E_4 I_4}$$

$$\delta_{13,T} = 0$$

$$\delta_{13,P} = 0$$

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 CHECKED BY: G. R. D.
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 TITLE: 75Y-4 PROPELLANT TANK

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 MODEL: DSV-4

REPORT NO. SM 42569

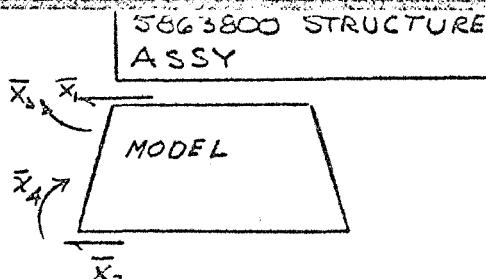
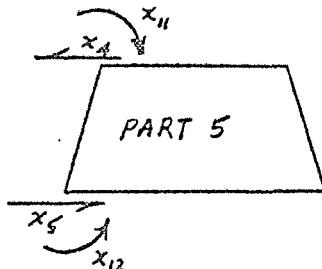
PART 5

$$x_4 = \bar{x}_1$$

$$x_5 = -\bar{x}_2$$

$$x_{11} = \bar{x}_3$$

$$x_{12} = -\bar{x}_4$$



$$\delta_{4,4} = + + = + \bar{\delta}_{6,1}$$

$$\delta_{4,5} = + - = - \bar{\delta}_{6,2}$$

$$\delta_{4,11} = + + = + \bar{\delta}_{6,3}$$

$$\delta_{4,12} = + - = - \bar{\delta}_{6,4}$$

$$\delta_{4,P} = \frac{P_m R^2 (1-\nu) \sin \phi^{4,5}}{2E_s x_5}$$

$$\delta_{4,T} = \alpha \Delta T_m R \sin \phi^{4,5}$$

$$\delta_{11,4} = + + = + \bar{\delta}_{3,1}$$

$$\delta_{11,5} = + - = - \bar{\delta}_{3,2}$$

$$\delta_{11,11} = + + = + \bar{\delta}_{3,3}$$

$$\delta_{11,12} = + - = - \bar{\delta}_{3,4}$$

$$\delta_{11,P} = 0$$

$$\delta_{11,T} = 0$$

$$\delta_{5,4} = - + = - \bar{\delta}_{2,1}$$

$$\delta_{5,5} = - - = + \bar{\delta}_{2,2}$$

$$\delta_{5,11} = - + = - \bar{\delta}_{2,3}$$

$$\delta_{5,12} = - - = + \bar{\delta}_{2,4}$$

$$\delta_{5,P} = - \frac{P_m R^2 (1-\nu) \sin \phi^{5,6}}{2E_s x_5}$$

$$\delta_{5,T} = - \alpha \Delta T_m R \sin \phi^{5,6}$$

$$\delta_{12,4} = - + = - \bar{\delta}_{4,1}$$

$$\delta_{12,5} = - - = + \bar{\delta}_{4,2}$$

$$\delta_{12,11} = - + = - \bar{\delta}_{4,3}$$

$$\delta_{12,12} = - - = + \bar{\delta}_{4,4}$$

$$\delta_{12,P} = 0$$

$$\delta_{12,T} = 0$$

$$\phi^{4,5} = 90^\circ - 13.020^\circ = \phi^{4,5} = 76.980^\circ$$

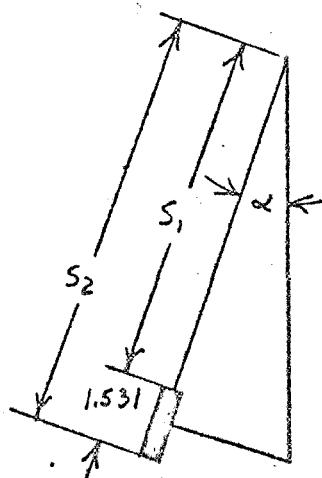
$$\phi^{5,6} = 90^\circ - 12.208^\circ = \phi^{5,6} = 77.792^\circ$$

$$x_5 = .250^\circ$$

$$\alpha = 12.614^\circ$$

$$S_1 = \frac{110}{\tan 12.614} - .766 = S_1 = 490.678$$

$$S_2 = \frac{110}{\tan 12.614} + .766 = S_2 = 492.210$$



PREPARED BY G. J. S.
 CHECKED BY G. R. H.
 DATE 1-9-62
 TITLE DSY-4 PROPELLANT TANK

BOEING AIRCRAFT COMPANY, INC.

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MODEL DSY-4

REPORT NO. SM 4756

PART 6

5863600 STRUCTURE
ASSY

$$\delta_{5,5}^6 = \frac{R B \sin^2 \phi^{5,6}}{E_6 I_6} \left(\frac{1}{K_1} + K_2 \right)$$

$$\delta_{5,12}^6 = \frac{2 B^2 \sin \phi^{5,6}}{E_6 I_6 K_1}$$

$$\delta_{5,P}^6 = \frac{P_0 R^2 (1-\nu) \sin \phi^{5,6}}{2 E_6 I_6}$$

$$\delta_{5,T}^6 = \alpha \Delta T_m R \sin \phi^{5,6}$$

$$\delta_{12,5}^6 = \delta_{5,12}^6$$

$$\delta_{12,12}^6 = \frac{4 B^3}{E_6 I_6 R K_1}$$

$$\delta_{R,P}^4 = 0$$

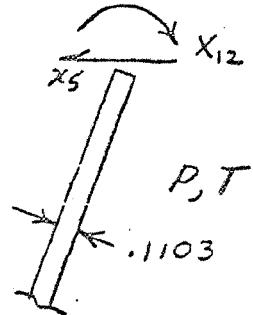
$$\delta_{R,T}^4 = 0$$

$$\phi^{5,6} = 90^\circ - 12.208^\circ = \phi^{5,6} = 77.792^\circ$$

$$B = \sqrt{3(1-\nu^2)} \left(\frac{R}{I_6} \right)^2$$

$$K_1 = 1 + \frac{1-2\nu}{2\beta} \cot \phi^{5,6}$$

$$K_2 = 1 + \frac{1-2\nu}{2\beta} \cot \phi^{5,6}$$



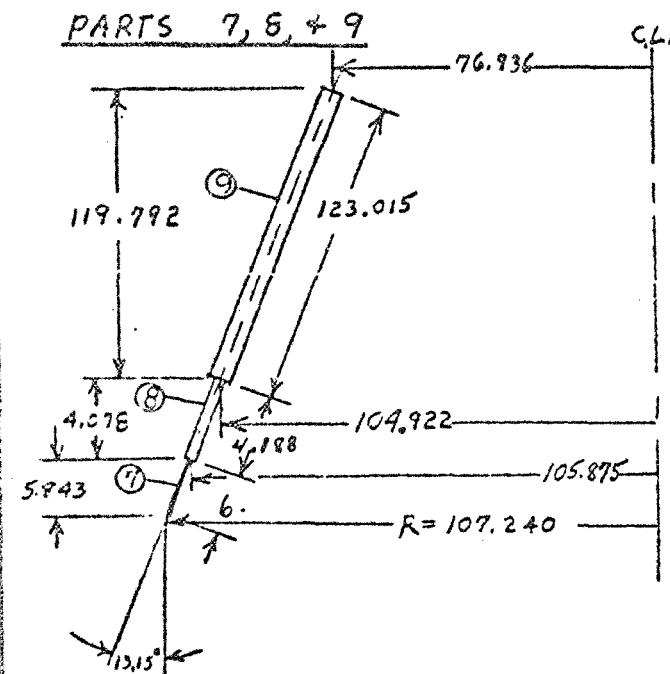
MCDONNELL AIRCRAFT COMPANY, INC.

PREPARED BY: G. J. S.
 CHECKED BY: G. K. H.
 DATE: 1-11-62
 TITLE: DSV-4 PROPELLANT TANK

SM

DIVISION

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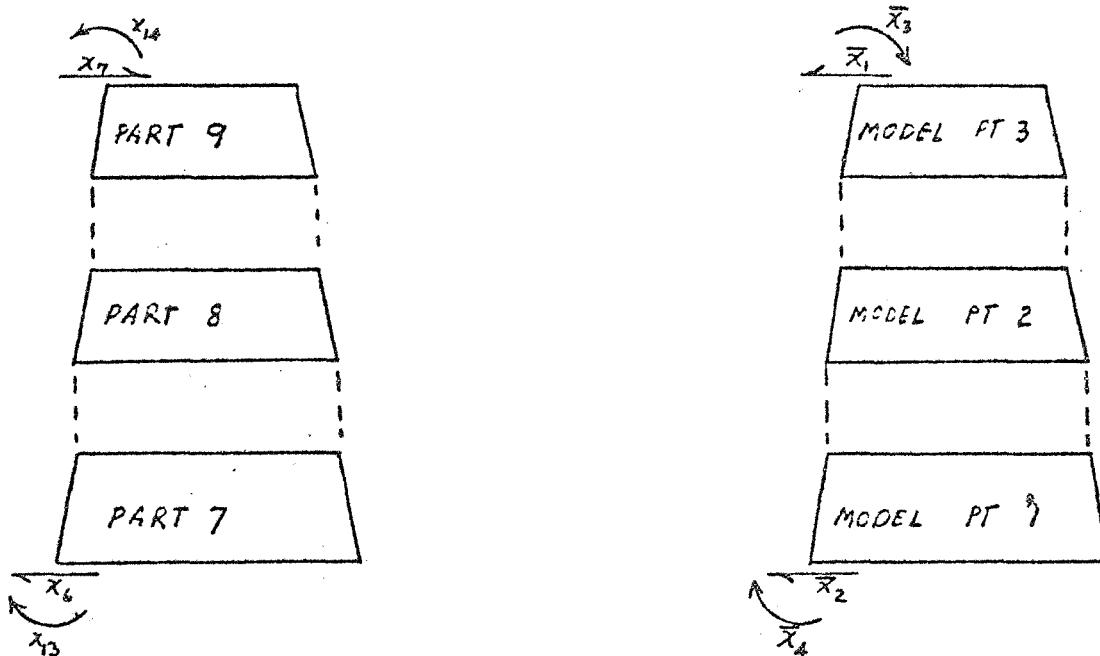
MODEL: DSV-4REPORT NO: SIM 42569

5863800 STRUCTURE
ASSY

$$x_7 = .250$$

$$x_8 = .504$$

$$x_9 = .490$$



PREPARED BY: G. J. S.
CHECKED BY: G. R. V.
DATE: 1-12-62
TITLE: DSY-A PROPELLANT TANK

DCUCLAS AIRCRAFT COMPANY, INC.

SM

DIVISION

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MODEL: DSY-A

REPORT NO: SM 42569

$$X_7 = - \bar{X}_1$$

CONE 1
 $R_1 = 105.815$

$$X_6 = \bar{X}_2$$

$$R_2 = 107.240$$

5865800 STRUCTURE
ASSY

$$X_{14} = - \bar{X}_3$$

$$\Delta Z = 5.843 \quad Z = .250$$

$$X_{13} = \bar{X}_4$$

CONE 2
 $R_1 = 104.922$

$$R_2 = 105.875$$

$$\Delta Z = 4.078 \quad Z = .504$$

PROGRAM SAOB

CONE 3
 $R_1 = 76.936$

$$R_2 = 104.922$$

$$\Delta Z = 119.792 \quad Z = .490$$

$$\delta_{7,7} = - - = + \bar{\delta}_{1,1}$$

$$\delta_{6,7} = + - = - \bar{\delta}_{2,1}$$

$$\delta_{7,6} = - + = - \bar{\delta}_{1,2}$$

$$\delta_{6,6} = + + = + \bar{\delta}_{2,2}$$

$$\delta_{7,14} = - - = + \bar{\delta}_{1,3}$$

$$\delta_{6,14} = + - = - \bar{\delta}_{2,3}$$

$$\delta_{7,13} = - + = - \bar{\delta}_{1,4}$$

$$\delta_{6,13} = + + = + \bar{\delta}_{2,4}$$

$$\delta_{7,T} = - \alpha \Delta T_{out} R_{1,CONE\ 3}$$

$$\delta_{6,T} = \alpha \Delta T_{out} R_{2,CONE\ 1}$$

$$\delta_{7,P_{out}} = \frac{P_{out} R_{1,CONE\ 3}^2 (1-\nu)}{2 E_7 \ Z_7}$$

$$\delta_{6,P_{out}} = - \frac{P_{out} R_{2,CONE\ 1}^2 (1-\nu)}{2 E_7 \ Z_7}$$

$$\delta_{14,7} = - - = + \bar{\delta}_{3,1}$$

$$\delta_{13,7} = + - = - \bar{\delta}_{3,1}$$

$$\delta_{14,6} = - + = - \bar{\delta}_{3,2}$$

$$\delta_{13,6} = + + = + \bar{\delta}_{4,2}$$

$$\delta_{14,14} = - - = + \bar{\delta}_{3,3}$$

$$\delta_{13,14} = + - = - \bar{\delta}_{4,3}$$

$$\delta_{14,13} = - + = - \bar{\delta}_{3,4}$$

$$\delta_{13,13} = + + = + \bar{\delta}_{4,4}$$

$$\delta_{14,T} = 0$$

$$\delta_{13,T} = 0$$

$$\delta_{14,P} = 0$$

$$\delta_{13,P} = 0$$

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DOUGLAS AIRCRAFT COMPANY, INC.

CHECKED BY G. R. D.DATE 1-17-62TITLE DSV-4 PROPELLANT TANKSM

DIVISION

PAGE III. 3-11MODEL DSV-4REPORT NO. SM 42569

5863800 STRUCTURE
ASSY

S₁

$$S'_{1,1} + S'_{1,8} + S'_{1,T} + S'_{1,P} + S^2_{1,1} + S^2_{1,2} + S^2_{1,8} + S^2_{1,9} + S^2_{1,P} + S^2_{1,T} = 0$$

S₂

$$S^2_{2,1} + S^2_{2,2} + S^2_{2,8} + S^2_{2,9} + S^2_{2,P} + S^2_{2,T} + S^3_{2,2} + S^3_{2,3} + S^3_{2,9} + S^3_{2,10} + S^3_{2,P} + S^3_{2,T} = 0$$

S₃

$$S^3_{3,2} + S^3_{3,3} + S^3_{3,9} + S^3_{3,10} + S^3_{3,P} + S^3_{3,T} + S^4_{3,3} + S^4_{3,4} + S^4_{3,6} + S^4_{3,10} + S^4_{3,11} + S^4_{3,13} + S^4_{3,N} + S^4_{3,T} + S^4_{3,P} = 0$$

S₄

$$S^4_{4,3} + S^4_{4,4} + S^4_{4,6} + S^4_{4,10} + S^4_{4,11} + S^4_{4,13} + S^4_{4,N} + S^4_{4,T} + S^4_{4,P} + S^5_{4,4} + S^5_{4,11} + S^5_{4,12} + S^5_{4,P} + S^5_{4,T} = 0$$

S₅

$$S^5_{5,4} + S^5_{5,5} + S^5_{5,11} + S^5_{5,12} + S^5_{5,P} + S^5_{5,T} + S^6_{5,5} + S^6_{5,12} + S^6_{5,P} + S^6_{5,T} = 0$$

S₆

$$S^4_{6,3} + S^4_{6,4} + S^4_{6,6} + S^4_{6,10} + S^4_{6,11} + S^4_{6,13} + S^4_{6,N} + S^4_{6,T} + S^4_{6,P} + S^7_{6,6} + S^7_{6,7} + S^7_{6,13} + S^7_{6,14} + S^7_{6,T} + S^7_{6,P} = 0$$

S₇

$$S^7_{7,6} + S^7_{7,7} + S^7_{7,13} + S^7_{7,14} + S^7_{7,T} + S^7_{7,P} = 0$$

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DATE 1-17-62
TITLE DSV-4 PROPELLANT TANK

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SM

DIVISION

PAGE III. 3.12MODEL DSV-4REPORT NO. 642550

5863800 STRUCTURE
ASSY

 δ_8

$$\delta_{8,1}^1 + \delta_{8,8}^1 + \delta_{8,P}^1 + \delta_{8,T}^1 + \delta_{8,1}^2 + \delta_{8,2}^2 + \delta_{8,8}^2 + \delta_{8,9}^2 + \delta_{8,P}^2 + \delta_{8,T}^2 = 0$$

 δ_9

$$\begin{aligned} \delta_{9,1}^2 + \delta_{9,2}^2 + \delta_{9,8}^2 + \delta_{9,9}^2 + \delta_{9,P}^2 + \delta_{9,T}^2 + \delta_{9,2}^3 + \delta_{9,3}^3 + \delta_{9,9}^3 + \delta_{9,10}^3 \\ + \delta_{9,P}^3 + \delta_{9,T}^3 = 0 \end{aligned}$$

 δ_{10}

$$\begin{aligned} \delta_{10,2}^3 + \delta_{10,3}^3 + \delta_{10,9}^3 + \delta_{10,10}^3 + \delta_{10,P}^3 + \delta_{10,T}^3 + \delta_{10,3}^4 + \delta_{10,4}^4 + \delta_{10,6}^4 + \delta_{10,10}^4 \\ + \delta_{10,13}^4 + \delta_{10,N}^4 + \delta_{10,T}^4 + \delta_{10,P}^4 = 0 \end{aligned}$$

 δ_{11}

$$\begin{aligned} \delta_{11,3}^4 + \delta_{11,4}^4 + \delta_{11,6}^4 + \delta_{11,10}^4 + \delta_{11,11}^4 + \delta_{11,13}^4 + \delta_{11,N}^4 + \delta_{11,T}^4 + \delta_{11,P}^4 + \delta_{11,4}^5 \\ + \delta_{11,5}^5 + \delta_{11,11}^5 + \delta_{11,12}^5 + \delta_{11,P}^5 + \delta_{11,T}^5 = 0 \end{aligned}$$

 δ_{12}

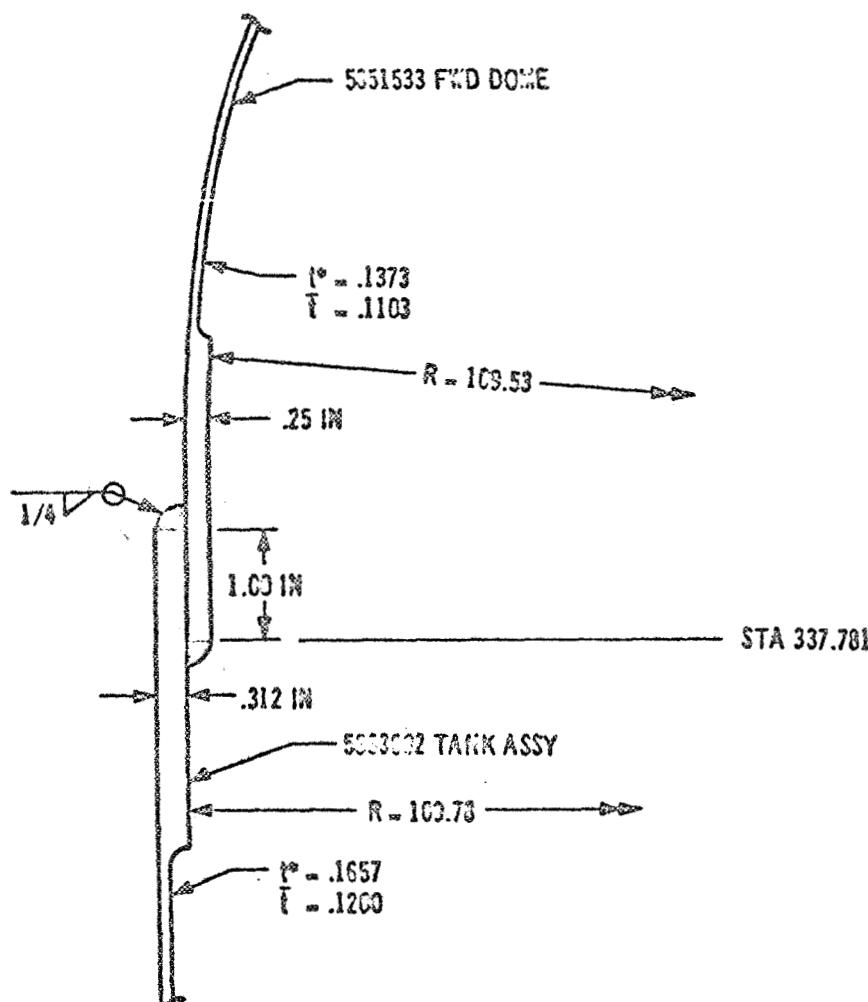
$$\delta_{12,4}^5 + \delta_{12,5}^5 + \delta_{12,11}^5 + \delta_{12,12}^5 + \delta_{12,P}^5 + \delta_{12,T}^5 + \delta_{12,5}^6 + \delta_{12,12}^6 + \delta_{12,P}^6 + \delta_{12,T}^6 = 0$$

 δ_{13}

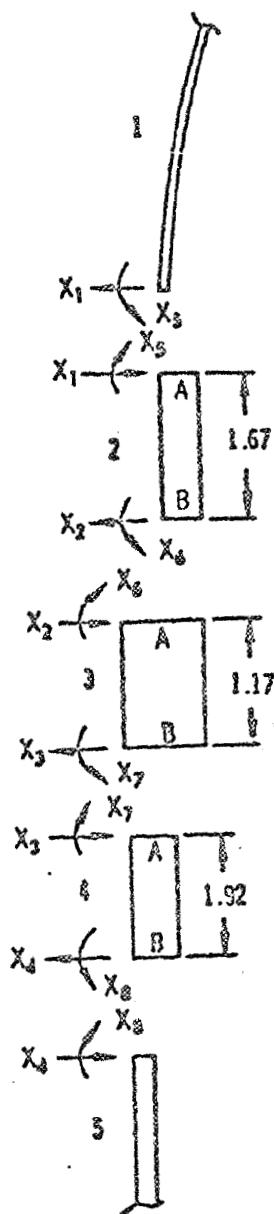
$$\begin{aligned} \delta_{13,3}^4 + \delta_{13,4}^4 + \delta_{13,6}^4 + \delta_{13,10}^4 + \delta_{13,11}^4 + \delta_{13,13}^4 + \delta_{13,N}^4 + \delta_{13,T}^4 + \delta_{13,P}^4 \\ + \delta_{13,6}^7 + \delta_{13,7}^7 + \delta_{13,13}^7 + \delta_{13,14}^7 + \delta_{13,T}^7 + \delta_{13,P}^7 = 0 \end{aligned}$$

 δ_{14}

$$\delta_{14,6}^7 + \delta_{14,7}^7 + \delta_{14,13}^7 + \delta_{14,14}^7 + \delta_{14,T}^7 + \delta_{14,P}^7 = 0$$

5003000
STRUCTURE ASSYFWD LH₂ DOME - TANK JOINT

FCD DOME - TANK JOINT

5533000
STRUCTURE ASSY

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DATE 7-10-63
TITLE DSV-4 PROPELLANT TANK

DOUGLAS AIRCRAFT COMPANY, INC.

SM

DIVISION

PAGE III.4.2
MODEL DSV-4
REPORT NO S 4425 B

PART 1 SPHERE

5863800
STRUCTURE ASSY

$$\delta_{1,1} = \frac{x_1}{E t^2} \cdot \beta R \sin^2 \phi (K_2 + \frac{1}{K_1})$$

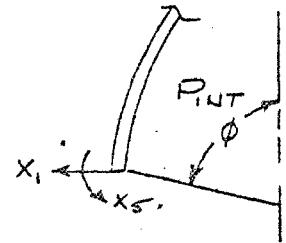
$$\delta_{1,5} = \frac{-x_5}{E t^2} \left[\frac{2 \beta^2 \sin^2 \phi}{K_1} \right]$$

$$\delta_{1,P} = \frac{\rho R^2}{2 E E} (1 - \nu)$$

$$\delta_{1,T} = +\alpha \Delta T R \sin^2 \phi$$

$$\delta_{5,1} = \delta_{1,5}$$

$$\delta_{5,5} = \frac{x_5}{E t^2} \left[\frac{4 \beta^3}{R K_1} \right]$$



$$\beta = \left[3(1 - \nu^2) \left(\frac{R}{E t^2} \right)^2 \right]^{1/4}$$

$$K_1 = 1 - \frac{1 - 2\nu}{2\beta} \cot \phi$$

$$K_2 = 1 - \frac{1 + 2\nu}{2\beta} \cot \phi$$

$$\nu = .3$$

PART 2

SHORT CYLINDER

$$\delta_{1,T} = -\alpha \Delta T R'$$

$$\delta_{1,1} = \frac{K x_1}{2 D B^4 L}$$

$$\delta_{1,2} = -\frac{K x_2}{2 D B^4 L}$$

$$\delta_{1,5} = \frac{K x_5}{2 D B^4 L^2}$$

$$\delta_{1,6} = \frac{K x_6}{2 D B^4 L^2}$$

$$\delta_{1,P} = -\frac{\rho R^2}{E E} (1 - \frac{K}{2})$$

$$\delta_{2,1} = \delta_{1,2}$$

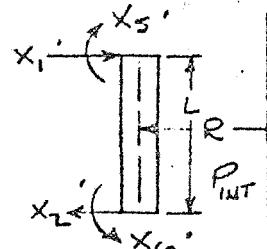
$$\delta_{2,2} = \delta_{1,1}$$

$$\delta_{2,5} = -\delta_{1,6}$$

$$\delta_{2,6} = -\delta_{1,5}$$

$$\delta_{2,P} = -\delta_{1,P}$$

$$\delta_{2,T} = +\alpha \Delta T R'$$



K = INFLUENCE COEFFICIENTS FOR SHORT CYLINDERS

$$\beta^4 = \frac{3(1 - \nu^2)}{R^2 E t^2}$$

$$D = \frac{E t^2}{12(1 - \nu^2)}$$

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 DATE: 7-16-3
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DESIGNING AEROMARINE COMPANY, INC.

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DIVISION

PAGE III. 4. 3

MODEL DSV-4

REPORT NO SM 42569

5863800

STRUCTURE ASSY

$$\delta_{5,1} = \delta_{1,5}$$

$$\delta_{6,1} = \delta_{1,6}$$

$$\delta_{5,2} = \delta_{2,5}$$

$$\delta_{6,2} = \delta_{2,6}$$

$$\delta_{5,5} = \frac{Kx_5}{20B^4L^3}$$

$$\delta_{6,5} = \delta_{5,6}$$

$$\delta_{5,6} = + \frac{Kx_6}{20B^4L^3}$$

$$\delta_{6,6} = \delta_{5,5}$$

PART 3

SHORT CYLINDER

$$\delta_{2,2} = \frac{Kx_2}{20B^4L}$$

$$\delta_{3,2} = \delta_{2,3}$$

$$\delta_{2,3} = \frac{-KK_3}{20B^4L}$$

$$\delta_{3,3} = \delta_{2,2}$$

$$\delta_{2,6} = \frac{Kx_6}{20B^4L^2}$$

$$\delta_{3,6} = -\delta_{2,7}$$

$$\delta_{2,7} = + \frac{Kx_7}{20B^4L^2}$$

$$\delta_{3,7} = -\delta_{2,6}$$

$$\delta_{2,P} = -\frac{PE^2}{EE} (1 - \frac{v}{c})$$

$$\delta_{3,P} = -\delta_{2,P}$$

$$\delta_{2,T} = -\alpha \Delta TR$$

$$\delta_{3,T} = +\alpha \Delta TR$$

$$\delta_{6,2} = \delta_{2,6}$$

$$\delta_{7,2} = \delta_{2,7}$$

$$\delta_{6,3} = \delta_{3,6}$$

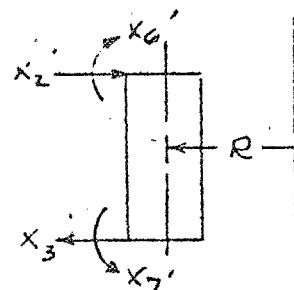
$$\delta_{7,3} = \delta_{3,7}$$

$$\delta_{6,6} = \frac{Kx_6}{20B^4L^3}$$

$$\delta_{7,6} = \delta_{6,7}$$

$$\delta_{6,7} = + \frac{Kx_7}{20B^4L^3}$$

$$\delta_{7,7} = \delta_{6,6}$$



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DOUGLAS AIRCRAFT COMPANY, INC.

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5863800

STRUCTURE ASSY

PART 4
SHORT CYLINDER

$$\delta_{3,3} = \frac{K X_3}{2 D B^4 L}$$

$$\delta_{4,3} = \delta_{3,4}$$

$$\delta_{3,4} = -\frac{K X_4}{2 D B^4 L}$$

$$\delta_{4,4} = \delta_{3,3}$$

$$\delta_{3,7} = \frac{K X_7}{2 D B^4 L^2}$$

$$\delta_{4,7} = -\delta_{3,8}$$

$$\delta_{3,8} = \frac{+K X_8}{2 D B^4 L^2}$$

$$\delta_{4,8} = -\delta_{3,7}$$

$$\delta_{3,P} = -\frac{P R^2}{E I} (1 - \frac{L}{2})$$

$$\delta_{4,P} = -\delta_{3,P}$$

$$\delta_{3,7} = -\alpha \Delta T R$$

$$\delta_{4,7} = +\alpha \Delta T R$$

$$\delta_{7,3} = \delta_{3,7}$$

$$\delta_{8,3} = \delta_{3,8}$$

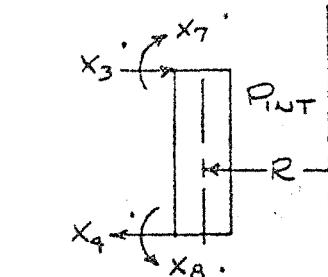
$$\delta_{7,4} = \delta_{4,7}$$

$$\delta_{8,4} = \delta_{4,8}$$

$$\delta_{7,7} = \frac{K X_7}{2 D B^4 L^3}$$

$$\delta_{8,7} = \delta_{7,8}$$

$$\delta_{7,8} = \frac{\pm K X_8}{2 D B^4 L^3}$$



88-64
6-28

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 TITLE DSV-4 PROPELLANT TANK

BELLING AIRCRAFT CORPORATION, INC.

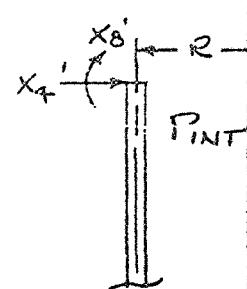
SM

DIVISION

PAGE III, 4, 5
 MODEL DSV-4REPORT NO SM 42569PART 5LONG CYLINDER

5863800

STRUCTURE ASSY



$$\delta_{4,4} = + \frac{X_4}{20\lambda^3}$$

$$\delta_{4,8} = + \frac{X_8}{20\lambda^2}$$

$$S_{4,P} = - \frac{PR^2}{EE} (1 - \frac{L}{z})$$

$$S_{4,T} = - \alpha \Delta T R$$

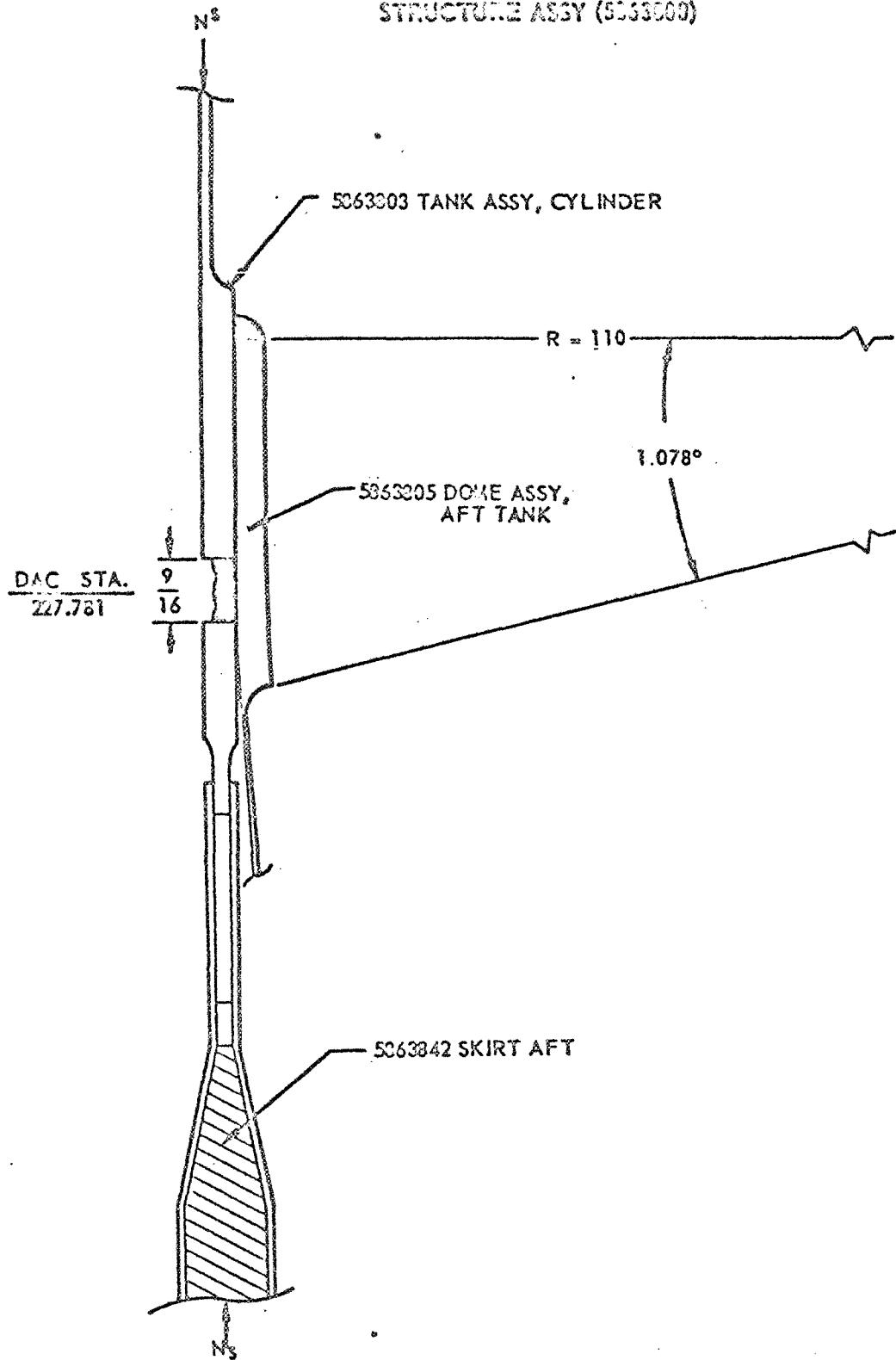
$$\delta_{8,4} = \delta_{4,8}$$

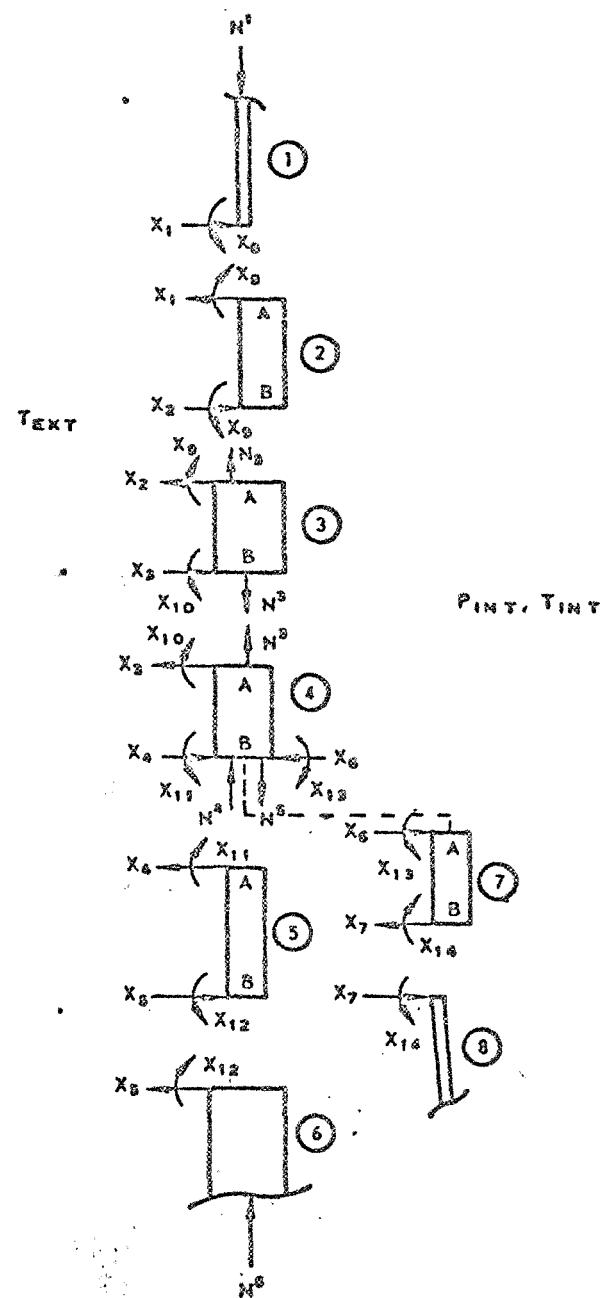
$$\delta_{8,8} = \frac{X_8}{\lambda D}$$

$$D = \frac{Et^3}{12(1-\nu^2)}$$

$$\lambda = \left[\frac{3(1-\nu^2)}{R^2 t^2} \right]^{1/4}$$

AFT SKIRT TO AFT LO₂ DOME JOINT
STRUCTURE ASSY (5063000)



AFT SKIRT TO AFT LO₂ DOME JOINT

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DUGLASS AIRCRAFT COMPANY, INC.

S.M.

DIVISION

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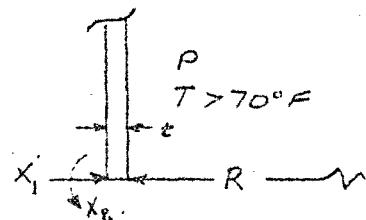
MODEL DSV-4

REPORT NO. SII 42569

PART 1

LONG CYLINDER

5863800 STRUCTURE
ASSY



$$R = \left[\frac{3(1-\gamma^2)}{\alpha^2 + t^2} \right]^{1/4}$$

$$D = \frac{E t^3}{12(1-\gamma^2)}$$

$$\delta_{1,1}' = + \frac{X_1}{2D\beta^3}$$

$$\delta_{1,8}' = + \frac{X_8}{2D\beta^2}$$

$$\dot{\delta}_{1,P}' = - \frac{PR^2}{Et} (1 - \frac{\gamma}{2})$$

$$\dot{\delta}_{1,T}' = - \Delta T R$$

$$\delta_{E,1}' = \delta_{1,8}'$$

$$\delta_{R,8}' = + \frac{X_8}{BD}$$

$$\delta_{B,P}' = \delta_{B,T}' = 0$$

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TITLE DSV-4 PROPELLANT TANK

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SM

DIVISION

PAGE III, 5, 3MODEL DSV-4REPORT NO. SM 42569PART 25863800 STRUCTURE ASSYSHORT CYLINDER

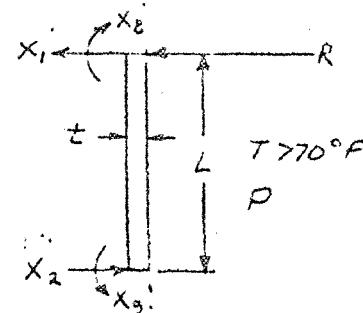
$$L = 1.6875'$$

$$t = .312'$$

$$\frac{r}{t} = \left[\frac{3(1-\gamma^2)}{L^2 t^2} \right]^{\frac{1}{4}} = \left[\frac{3(1-.3^2)}{110^2 (.312)^2} \right]^{\frac{1}{4}} = (23.175 \times 10^{-9})^{\frac{1}{4}} = .2194$$

$$EL = .2194 (1.6875) = .3703$$

$$D = \frac{Et^3}{12(1-\gamma^2)}$$



$$\tilde{\epsilon}_{1,1}^2 = + \frac{2.0004}{2DB^4 L} X_1$$

$$\tilde{\epsilon}_{1,2}^2 = + \frac{.3397}{2DB^4 L} X_2$$

$$\tilde{\epsilon}_{1,8}^2 = - \frac{3.0022}{2DB^4 L^2} X_8$$

$$\tilde{\epsilon}_{1,9}^2 = + \frac{2.9988}{2DB^4 L^2} X_9$$

$$\tilde{\epsilon}_{1,P}^2 = + \frac{PR^2(1-\gamma)}{Et}$$

$$\tilde{\epsilon}_{1,T}^2 = + \alpha \Delta T R$$

$$\delta_{2,1}^2 = + \delta_{1,2}^2$$

$$\delta_{2,2}^2 = + \delta_{1,1}^2$$

$$\delta_{2,8}^2 = - \frac{2.9988}{2DB^4 L^2} X_8$$

$$\delta_{2,9}^2 = + \frac{3.0022}{2DB^4 L^2} X_9$$

$$\delta_{2,P}^2 = - \frac{PR^2(1-\gamma)}{Et}$$

$$\delta_{2,T}^2 = - \alpha \Delta T R$$

$$\delta_{8,1}^2 = \delta_{1,8}^2$$

$$\delta_{8,2}^2 = \delta_{2,8}^2$$

$$\delta_{8,8}^2 = + \frac{6.0152}{2DB^4 L^3} X_8$$

$$\delta_{8,9}^2 = - \frac{5.9948}{2DB^4 L^3} X_9$$

$$\delta_{9,1}^2 = \delta_{1,9}^2$$

$$\delta_{9,2}^2 = \delta_{2,9}^2$$

$$\delta_{9,8}^2 = \delta_{8,9}^2$$

$$\delta_{9,9}^2 = \delta_{8,8}^2$$

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CHECKED BY G.J.S.
DATE 3/16/63
TITLE DSV-4 PROPELLANT TANK

DOUGLAS AIRCRAFT COMPANY, INC.

SM

DIVISION

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MODEL DSV-4

REPORT NO. SM 42569

PART 3 SHORT CYLINDER

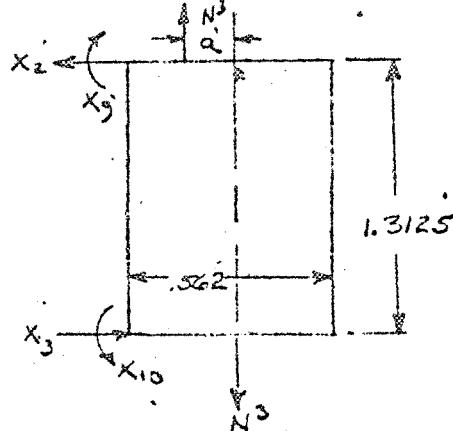
5863800 STRUCTURE
ASSY.

$$R = 110^{\circ}$$

$$t = .562^{\circ}$$

$$\gamma = .3^{\circ}$$

$$L = 1.3125^{\circ}$$



$$R^4 = \frac{3(1-\gamma^2)}{R^2 t^2} = \frac{3(1-.09)}{110^2 (.562)^2}$$

$$= .0007143^{\circ}$$

$$B = .1635^{\circ}$$

$$BL = .2146^{\circ}$$

$$S_{2,2}^3 = \frac{1.99844}{2DB^4 L} X_2$$

$$S_{2,3}^3 = \frac{.99838}{2DB^4 L} X_3$$

$$S_{2,9}^3 = \frac{-2.99721}{2DB^4 L^2} X_9$$

$$S_{2,10}^3 = \frac{2.99677}{2DB^4 L^2} X_{10}$$

$$S_{2,N^3}^3 = -\frac{2.99721}{2DB^4 L^2} N^3 a$$

$$S_{2,P}^3 = +\frac{PR^2(1-\gamma/2)}{Et}$$

$$S_{2,T}^3 = +\alpha \Delta TR$$

$$S_{3,2}^3 = S_{2,3}^3$$

$$S_{3,3}^3 = S_{2,2}^3$$

$$S_{3,9}^3 = -S_{2,10}^3$$

$$S_{3,10}^3 = -S_{2,9}^3$$

$$S_{3,N^3}^3 = -\frac{2.99677}{2DB^4 L^2} N^3 a$$

$$S_{3,P}^3 = -\frac{PR^2(1-\gamma/2)}{Et}$$

$$S_{3,T}^3 = -\alpha \Delta TR$$

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SM

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PAGE III.5.5
MODEL DSV-4
REPORT NO SC 42549PART 35B63800 STRUCTURE
ASSY

$$\cdot S_{9,2}^3 = S_{2,9}^3$$

$$\cdot S_{9,3}^3 = S_{3,9}^3$$

$$\cdot S_{9,9}^3 = \frac{5.99572}{2DB^4L^3} X_9$$

$$\cdot S_{9,10}^3 = -\frac{5.99316}{2DB^4L^3} X_{10}$$

$$\cdot S_{9,N^3}^3 = \frac{5.99572}{2DB^4L^3} N^3 a$$

$$\cdot S_{10,2}^3 = S_{2,10}^3$$

$$\cdot S_{10,3}^3 = S_{3,10}^3$$

$$\cdot S_{10,9}^3 = S_{9,10}^3$$

$$\cdot S_{10,10}^3 = S_{9,9}^3$$

$$\cdot S_{10,N^3}^3 = -\frac{5.99316}{2DB^4L^3} N^3 a$$

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DATE: 1/15/62
TITLE: DSV-4 PROPELLANT TANK

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PAGE: 11.5, 6

SM

MODEL: DSV-4

REPORT NO: S7142569

PART 4 SHORT CYLINDER

5803800 STRUCTURE
ASSY

$$\tau > 70^\circ F \quad \gamma = .3$$

$$R = 110$$

$$t = .468$$

$$L = .563$$

N^4 = SKIRT LOAD

N^5 = PRESSURE LOAD

N^3 = RESULTANT LOAD

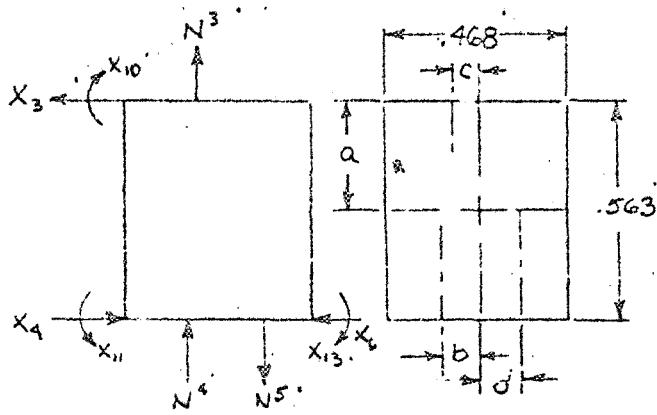
$$B^4 = \frac{3(1-\gamma^2)}{R^2 t^2}$$

$$B^4 = \frac{3(1-.09)}{110^2 (.468)^2} = .103 \times 10^{-2}$$

$$B = .1792$$

$$BL = (.1792 \times .563) = .1008$$

$$C = \frac{Et^3}{12(1-\gamma^2)} = \frac{10.3(10^6)(.468)^3}{12(1-.09)} = 96,683.4$$



PREPARED BY: G. R. H.
CHECKED BY: G. R. H.
DATE: 7/1/62
TITLE: DEV-A PROOF

PRECIOUS METAL COMPANY, INC.

PAGE # III.5.7
MODEL # DSV-4
REPORT NO. SM 4256

PART 4

5863800 STRUCTURE
ASSY

$$\therefore \zeta_{3,3}^4 = \frac{1.97059^\circ}{2DB^4 L} X_3$$

$$\therefore S_{3,4}^4 = \frac{.97059}{ZDB^4 L} X_9$$

$$\cdot S_{3,6}^4 = - \frac{.97059}{203^4 L} x_6$$

$$S_{3,10}^4 = - \frac{2.94118}{25\beta^4 L^2} \times 10$$

$$S_{3,11}^4 = + \frac{2.94118}{20\beta^4 L^2} K_{11}$$

$$S_{3,13}^4 = -\frac{2.34118}{2034.62} x_{13}$$

$$S_{3,N}^9 = - \frac{2.34118}{20B^4 h^2} N^3 C$$

$$\cdot S_{3,N^4}^4 = -\frac{234118}{20\beta^4 k^2} N^4 b$$

$$S_{3,N^5}^9 = -\frac{2.94118}{203912} N^5 d$$

$$S_{3,P}^4 = \frac{PR^2}{EF} \left(1 - \frac{r_1}{r_2}\right)$$

$$\cdot S_{3,T}^4 = \lambda \Delta T R$$

$$S_{7,4}^4 = S_{3,4}^4$$

$$S_{4,4}^4 = + S_{3,3}^9$$

$$S_{4,6}^4 = - S_{4,4}^4.$$

$$\cdot S_{4,10}^4 = - S_{3,11}^4$$

$$\cdot \mathcal{S}_{4,11}^4 = - \mathcal{S}_{3,10}^4$$

$$\cdot \quad \mathcal{E}_{4,13}^4 = - \mathcal{E}_{9,11}^4$$

$$\cdot \delta_{4, N^3}^4 = - \frac{z \cdot 94118}{z \cdot DB^4 f^2} N^3 C$$

$$\therefore \sum_{N=1}^4 N^4 = -\frac{2.34118}{208^4 \pi^2} N^4 b$$

$$S_{4,N^5}^4 = - \frac{2.94118}{2DB^4L^2} N^5 d$$

$$\therefore \mathcal{E}_{A,P}^4 = - \frac{\rho R^2}{E t} (1 - \frac{r_0}{r})$$

$$\cdot S_{A,T}^4 = - d\Delta T R$$

PREPARED BY: G. R. S.
CHECKED BY: G. J. S.
DATE: 8-16-62
TITLE: DEV-4 PROPELLANT TANK

DOUGLAS AIRCRAFT COMPANY, INC.

SM

DIVISION

PAGE III-5, B
MODEL: DSV-4
REPORT NO. SM 4-569

PART 4

5863800 STRUCTURE
ASSY

$$\cdot \delta_{6,3}^4 = \delta_{3,6}^4$$

$$\cdot \delta_{6,4}^4 = \delta_{4,6}^4$$

$$\cdot \delta_{6,6}^4 = \delta_{4,4}^4$$

$$\cdot \delta_{6,10}^4 = -\delta_{4,10}^4$$

$$\cdot \delta_{6,11}^4 = -\delta_{4,11}^4$$

$$\cdot \delta_{6,13}^4 = -\delta_{4,13}^4$$

$$\cdot \delta_{6,N^3}^4 = -\delta_{4,N^3}^4$$

$$\cdot \delta_{6,N^4}^4 = -\delta_{4,N^4}^4$$

$$\cdot \delta_{6,N^5}^4 = -\delta_{4,N^5}^4$$

$$\cdot \delta_{6,P}^4 = -\delta_{4,P}^4$$

$$\cdot \delta_{6,T}^4 = -\delta_{4,T}^4$$

$$\cdot \delta_{10,3}^4 = \delta_{3,10}^4$$

$$\cdot \delta_{10,4}^4 = \delta_{4,10}^4$$

$$\cdot \delta_{10,6}^4 = \delta_{6,10}^4$$

$$\cdot \delta_{10,10}^4 = \frac{5.88241}{2DB^4L^3} X_{10}$$

$$\cdot \delta_{10,11}^4 = -\frac{5.88229}{2DB^4L^3} X_{11}$$

$$\cdot \delta_{10,13}^4 = -\delta_{10,11}^4$$

$$\cdot \delta_{10,N^3}^4 = \frac{5.88241}{2DB^4L^3} N^3 C$$

$$\cdot \delta_{10,N^4}^4 = \frac{5.88229}{2DB^4L^3} N^4 D$$

$$\cdot \delta_{10,N^5}^4 = \frac{5.88229}{2DB^4L^3} N^5 E$$

PREPARED BY G.R.14
CHECKED BY G.J.S.
DATE 3/62
TITLE D9V-4 PROPELLANT TANK

DOUGLAS AIRCRAFT COMPANY, INC.

SM

DIVISION

PAGE III-5.9MODEL D5V-4REPORT NO. SM 42565PART 45863800 STRUCTURE
ASSY

- $\delta_{11,3}^4 = \delta_{3,11}^4$
- $\delta_{11,4}^4 = \delta_{4,11}^4$
- $\delta_{11,6}^4 = \delta_{6,11}^4$
- $\delta_{11,10}^4 = \delta_{10,11}^4$
- $\delta_{11,11}^4 = \delta_{10,10}^4$
- $\delta_{11,13}^4 = -\delta_{11,11}^4$
- $\delta_{11,N^3}^4 = -\frac{5.88229}{20B^4L^3} N^3 C$
- $\delta_{11,N^4}^4 = -\frac{5.88291}{20B^4L^3} N^4 b$
- $\delta_{11,N^5}^4 = -\frac{5.88241}{20B^4L^3} N^5 d$

- $\delta_{13,3}^4 = \delta_{3,13}^4$
- $\delta_{13,4}^4 = \delta_{4,13}^4$
- $\delta_{13,6}^4 = \delta_{6,13}^4$
- $\delta_{13,10}^4 = \delta_{10,13}^4$
- $\delta_{13,11}^4 = \delta_{11,13}^4$
- $\delta_{13,13}^4 = \delta_{11,11}^4$
- $\delta_{13,N^3}^4 = -\delta_{11,N^3}^4$
- $\delta_{13,N^4}^4 = -\delta_{11,N^4}^4$
- $\delta_{13,N^5}^4 = -\delta_{11,N^5}^4$

PREPARED BY G.S.
 CHECKED BY G.T.S.
 DATE 3/13/62
 TITLE DSV-4 PROPELLANT TANK

BOEING AIRCRAFT COMPANY, INC.

SM DIVISION

PAGE III.5.10
 MODEL DSV-4
 REPORT NO. S/N 42569

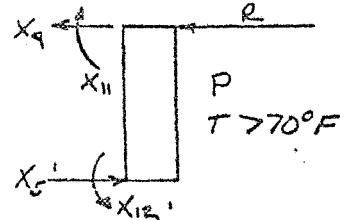
PART 5

LONG CYLINDER

$$\beta = \left[\frac{3(1-\gamma^2)}{R^2 t^2} \right]^{\frac{1}{4}}$$

$$D = \frac{Et^3}{12(1-\gamma^2)}$$

5BC3E00 STRUCTURE
ASSY



$$\delta_{4,4}^5 = \frac{x_4}{2D\beta^3}$$

$$\delta_{4,11}^5 = -\frac{x_{11}}{2D\beta^2}$$

$$\delta_{4,0}^5 = +\frac{PR^2(1-\gamma)}{Et}$$

$$\delta_{4,T}^5 = +\alpha \Delta T R$$

$$\delta_{4,5}^5 = \delta_{4,12}^5 = 0$$

$$\delta_{11,4}^5 = \delta_{4,11}^5$$

$$\delta_{11,11}^5 = \frac{x_{11}}{\beta D}$$

$$\delta_{11,9}^5 = \delta_{11,12}^5 = 0$$

$$\delta_{5,5}^5 = +\frac{x_5}{2D\beta^3}$$

$$\delta_{5,12}^5 = +\frac{x_{12}}{2D\beta^2}$$

$$\delta_{5,0}^5 = -\frac{PR^2(1-\gamma)}{Et}$$

$$\delta_{5,T}^5 = -\alpha \Delta T R$$

$$\delta_{12,5}^5 = \delta_{5,12}^5$$

$$\delta_{12,12}^5 = +\frac{x_{12}}{\beta D}$$

PREPARED BY G.R.H.
CHECKED BY G.L.T.S.
DATE 2/12/60
TITLE DSV-4 PROPELLANT TANK

DOUGLAS AIRCRAFT COMPANY, INC.

SM DIVISION

PAGE III, 5.11
MODEL DSV-4
REPORT NO. SM 42569

PART G

5863800 STRUCTURE
ASSY

$$B = \left[\frac{3(1-\gamma^2)}{R^2 t^2} \right]^{\frac{1}{4}}$$

$$D = \frac{E t^3}{12(1-\gamma^2)}$$

$$\delta_{S,5}^G = \frac{x_5}{2D\beta^3}$$

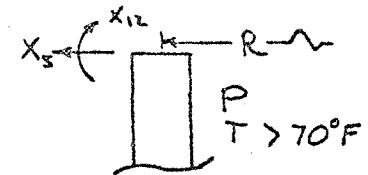
$$\delta_{S,12}^G = -\frac{x_{12}}{2D\beta^2}$$

$$\delta_{S,P}^G = +\frac{PR^2(1-\frac{y}{z})}{Et}$$

$$\delta_{S,T}^G = +\alpha \Delta TR$$

$$\delta_{12,5}^G = \delta_{S,12}^G$$

$$\delta_{12,12}^G = +\frac{x_{12}}{\beta D}$$



DOUGLAS AIRCRAFT COMPANY, INC.

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 DATE 2/2/62
 TITLE DSV-4 PROPELLANT TANK

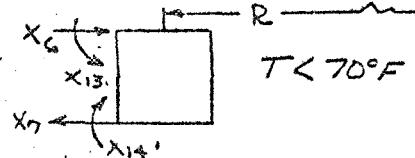
SM

DIVISION

PAGE III-5.12

MODEL DSV-4

REPORT NO. SM 4256 0

PART 7SHORT CYLINDER5863800 STRUCTURE
ASSY

$$L = 1.50'$$

$$t = .25'$$

$$R = 109.656'$$

$$B = \left[\frac{3(1-\gamma^2)}{R^2 t^2} \right]^{\frac{1}{4}} = \left[\frac{3(1-3^2)}{109.656^2 (.25)^2} \right]^{\frac{1}{4}} = (36.326 \times 10^{-4})^{\frac{1}{4}} = .2455'$$

$$BL = (.2455)(1.50) = .3682$$

$$\delta_{6,6}^7 = +\frac{2.0004}{2DB^4L} x_6$$

$$\delta_{6,7}^7 = +\frac{.9997}{2DB^4L} x_7$$

$$\delta_{6,13}^7 = -\frac{3.0022}{2DB^4L^2} x_{13}$$

$$\delta_{6,14}^7 = +\frac{2.9988}{2DB^4L^2} x_{14}$$

$$\delta_{6,P}^7 = -\frac{PR^2(1-\gamma)}{Et}$$

$$\delta_{6,T}^7 = -\alpha \Delta TR$$

$$\delta_{7,6}^7 = \delta_{6,7}^7$$

$$\delta_{7,7}^7 = \delta_{6,6}^7$$

$$\delta_{7,13}^7 = -\delta_{6,14}^7$$

$$\delta_{7,14}^7 = -\delta_{6,13}^7$$

$$\delta_{7,P}^7 = -\delta_{6,P}^7$$

$$\delta_{7,T}^7 = +\alpha \Delta TR$$

$$\delta_{13,6}^7 = \delta_{6,13}^7$$

$$\delta_{13,7}^7 = \delta_{7,13}^7$$

$$\delta_{13,13}^7 = +\frac{6.0150}{20B^4L^3} x_{13}$$

$$\delta_{13,14}^7 = -\frac{5.9950}{20B^4L^3} x_{14}$$

$$\delta_{14,6}^7 = \delta_{6,14}^7$$

$$\delta_{14,7}^7 = \delta_{7,14}^7$$

$$\delta_{14,13}^7 = \delta_{13,14}^7$$

$$\delta_{14,14}^7 = \delta_{13,13}^7$$

PREPARED BY G.R.H.
CHECKED BY S. J. S.
DATE 2/21/62
TITLE DSV-4 PROPELANT TANK

DOUGLAS AIRCRAFT COMPANY, INC.

SM

DIVISION

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MODEL DSV-4

REPORT NO. SH 42 E G

PART 8

SPHERE

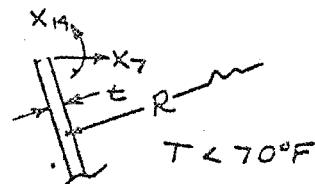
5863800 STRUCTURE
ASSY

$$B = \left[\frac{3(1-\gamma^2)(R)^2}{(E)^2} \right]^{1/4}$$

$$K_1 = 1 - \frac{1-2\gamma}{2B} \cot \phi$$

$$K_2 = 1 - \frac{1+2\gamma}{2B} \cot \phi$$

$$\phi' = 90 - .7838 = 89.2162^\circ$$



$$S_{7,7}^8 = \frac{X_7}{Et} RB \sin^2 \phi \left(\frac{1}{K_1} + K_2 \right)$$

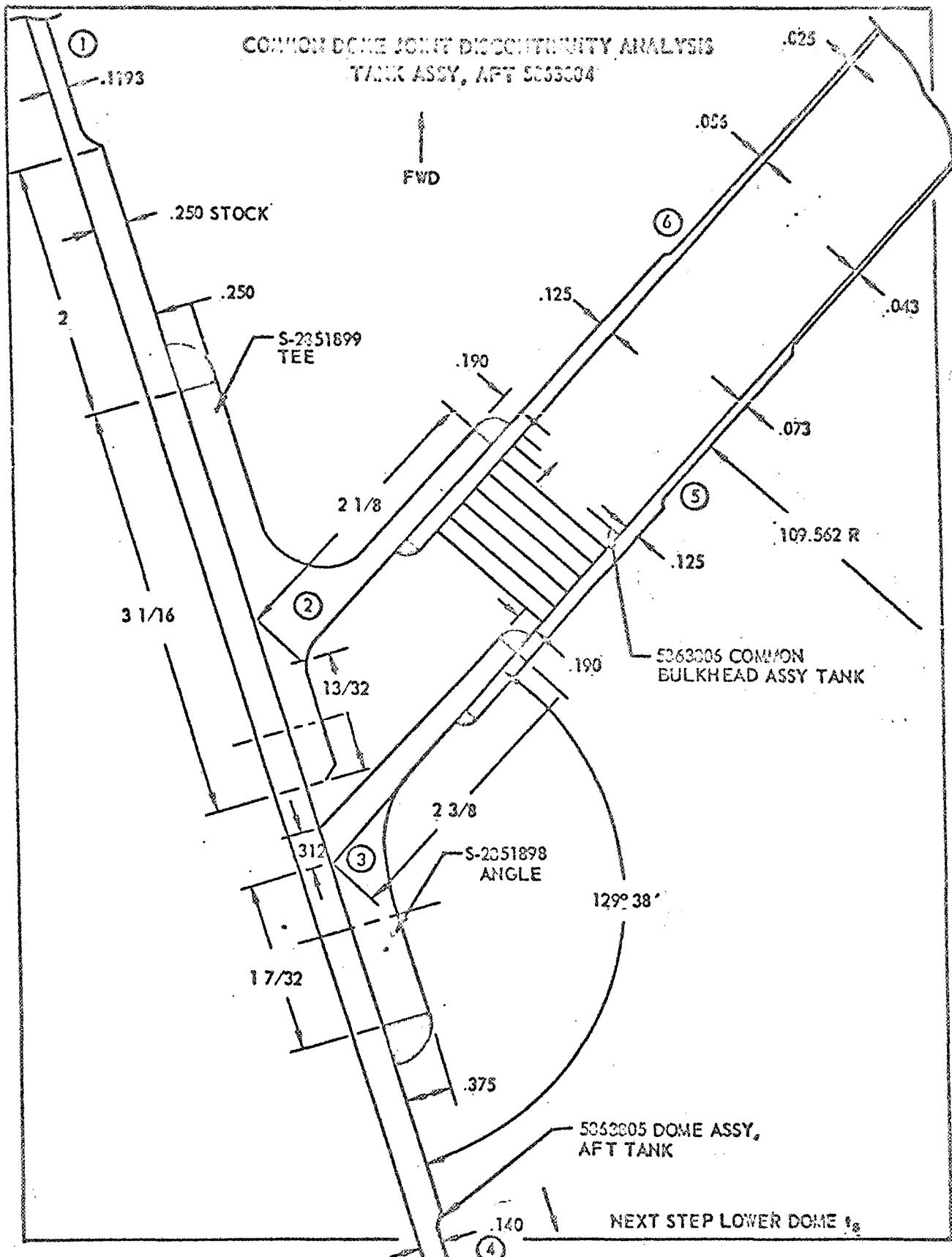
$$S_{7,14}^8 = - \frac{2B^2 \sin \phi}{Et K_1} X_{14}$$

$$S_{7,P}^8 = - \frac{PR^2(1-\gamma) \sin \phi}{2Et}$$

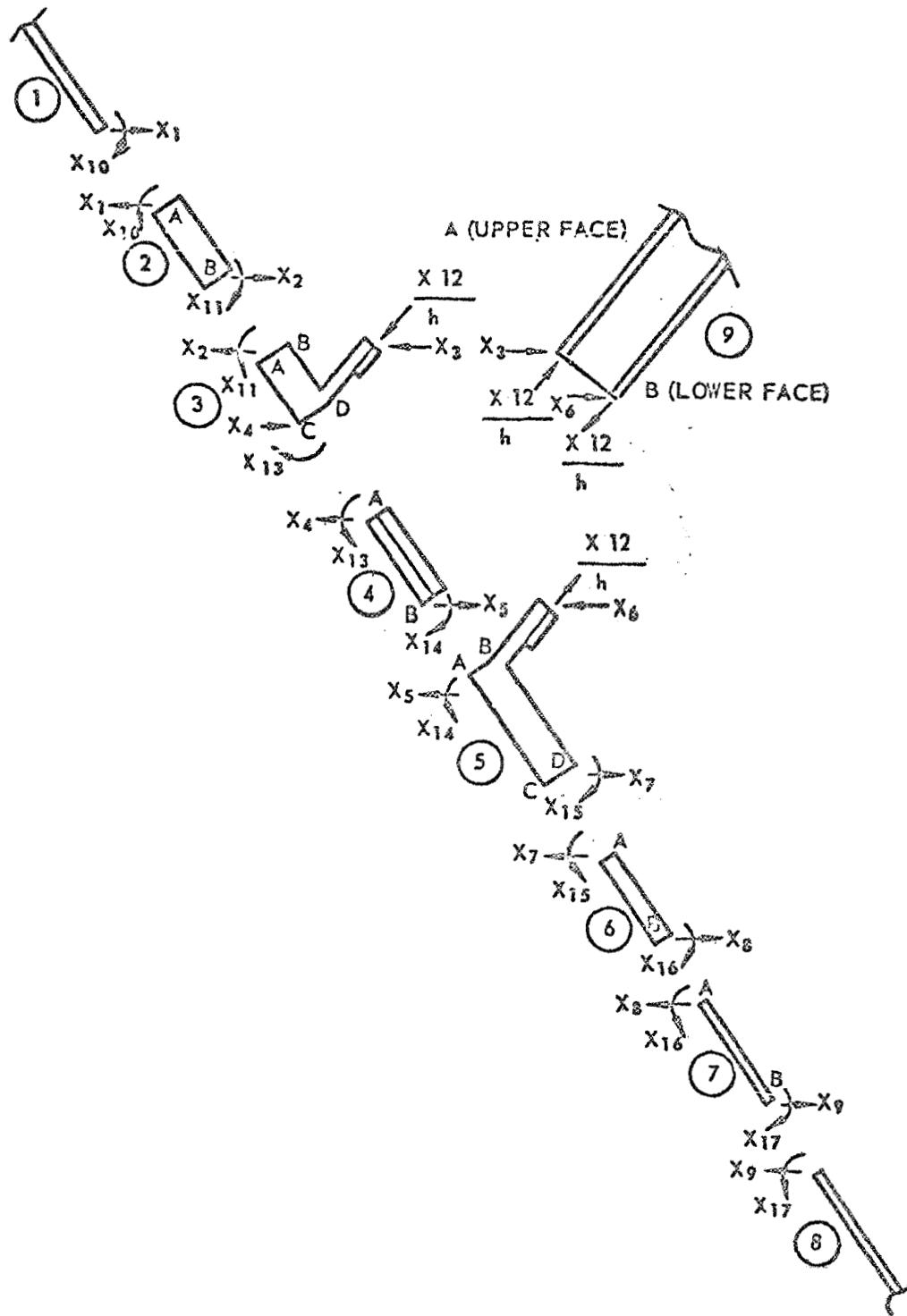
$$S_{7,T}^8 = - \Delta T R \sin \phi$$

$$S_{14,7}^8 = S_{7,14}^8$$

$$S_{14,14}^8 = \frac{4B^3 X_{14}}{Et R K_1}$$



COMMON DOME JOINT DISCONTINUITY ANALYSIS



PREPARED BY GRH
 CHECKED BY G. F. S.
 DATE 11/21/62
 TITLE DSV-4 PEGEELANT TANK

DOUGLAS AIRCRAFT COMPANY, INC.

SM

DIVISION

PAGE III, 6, 2

MODEL DSV-4

REPORT NO. SM 42569

PART 1 SPHERE

5863804 TANK
ASSY, AFT

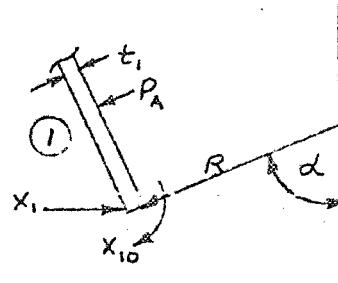
$$\lambda = \sqrt{3(1-v^2)(\frac{R}{E})^2}$$

λ = EDGE ANGLE

$$0 < \alpha < 90^\circ$$

$$K_1 = 1 + \frac{1-2v}{2\lambda} \cot \alpha$$

$$K_2 = 1 + \frac{1+2v}{2\lambda} \cot \alpha$$



$$\dot{\delta}_{1,1}' = \frac{R \lambda_1 \sin^2 \alpha}{E_1 t_1} (\frac{1}{R_1} + K_2) \dot{x}_1$$

$$\dot{\delta}_{1,10}' = -\frac{2\lambda^2 \sin \alpha \dot{x}_{10}}{E_1 t_1 K_1}$$

$$\dot{\delta}_{1,P_A}' = -\frac{P_A R^2}{2 E_1 t_1} (1-v) \sin \alpha$$

$$\dot{\delta}_{1,T_1}' = -\alpha_1 \Delta T_1 R \sin \alpha$$

$$\dot{\delta}_{10,1}' = -\frac{2\lambda^2 \sin \alpha}{E_1 t_1 K_1} \dot{x}_1 = \dot{\delta}_{1,10}'$$

$$\dot{\delta}_{10,10}' = \frac{4\lambda^3 \dot{x}_{10}}{E_1 t_1 K_1 R}$$

$$\dot{\delta}_{10,P}' = \dot{\delta}_{10,T}' = 0$$

PREPARED BY L.F. 32
 CHECKED BY G.S.
 DATE 1/22/62
 TITLE DC-1-6 PERMANENT TANK

DOUGLAS AIRCRAFT COMPANY, INC.

SM

DIVISION

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MODEL DSV-7

REPORT NO. S1142569

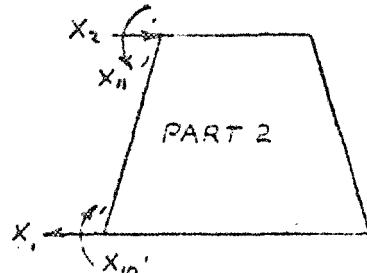
PART 2 CONE

$$X_1 = \bar{X}_3'$$

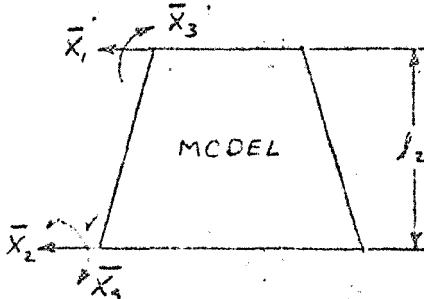
$$X_2 = -\bar{X}_1'$$

$$X_{10} = \bar{X}_4'$$

$$X_{11} = -\bar{X}_3'$$



5863804 TANK
ASSY, AFT



$$\delta_{1,1}^2 = + + \bar{\delta}_{2,2}^2 = + \bar{\delta}_{2,2}'$$

$$\delta_{1,2}^2 = + - \bar{\delta}_{2,1}^2 = - \bar{\delta}_{2,1}'$$

$$\delta_{1,10}^2 = + + \bar{\delta}_{2,9}^2 = + \bar{\delta}_{2,9}'$$

$$\delta_{1,11}^2 = + - \bar{\delta}_{2,3}^2 = - \bar{\delta}_{2,3}'$$

$$\delta_{1,T}^2 = + \Delta T_2 R \sin \alpha'$$

$$\delta_{1,P}^2 = + \frac{P R^2 (1-\nu)}{2 E_2 t_2} \sin \alpha'$$

$$\delta_{2,1}^2 = - + \bar{\delta}_{1,2}^2 = - \bar{\delta}_{1,2}'$$

$$\delta_{2,2}^2 = + - \bar{\delta}_{1,1}^2 = + \bar{\delta}_{1,1}'$$

$$\delta_{2,10}^2 = - + \bar{\delta}_{1,9}^2 = - \bar{\delta}_{1,9}'$$

$$\delta_{2,11}^2 = - - \bar{\delta}_{1,3}^2 = + \bar{\delta}_{1,3}'$$

$$\delta_{2,T}^2 = - \Delta T_2 R \sin \alpha'$$

$$\delta_{2,P}^2 = - \frac{P A R^2 (1-\nu)}{2 E_2 t_2} \sin \alpha'$$

$$\delta_{10,1}^2 = + + \bar{\delta}_{4,2}^2 = + \bar{\delta}_{4,2}'$$

$$\delta_{10,2}^2 = + - \bar{\delta}_{4,1}^2 = - \bar{\delta}_{4,1}'$$

$$\delta_{10,10}^2 = + + \bar{\delta}_{4,9}^2 = + \bar{\delta}_{4,9}'$$

$$\delta_{10,11}^2 = + - \bar{\delta}_{4,3}^2 = - \bar{\delta}_{4,3}'$$

$$\delta_{10,T}^2 = 0'$$

$$\delta_{10,P}^2 = 0'$$

$$\delta_{11,1}^2 = - + \bar{\delta}_{3,2}^2 = - \bar{\delta}_{3,2}'$$

$$\delta_{11,2}^2 = - - \bar{\delta}_{3,1}^2 = + \bar{\delta}_{3,1}'$$

$$\delta_{11,10}^2 = - + \bar{\delta}_{3,9}^2 = - \bar{\delta}_{3,9}'$$

$$\delta_{11,11}^2 = - - \bar{\delta}_{3,3}^2 = + \bar{\delta}_{3,3}'$$

$$\delta_{11,T}^2 = 0'$$

$$\delta_{11,P}^2 = 0'$$

PREPARED BY G.R.H.
CHECKED BY G.T.S.
DATE 11/6/2
TITLE DEV-4 PROPELLANT TANK

DODGE AIRCRAFT COMPANY, INC.

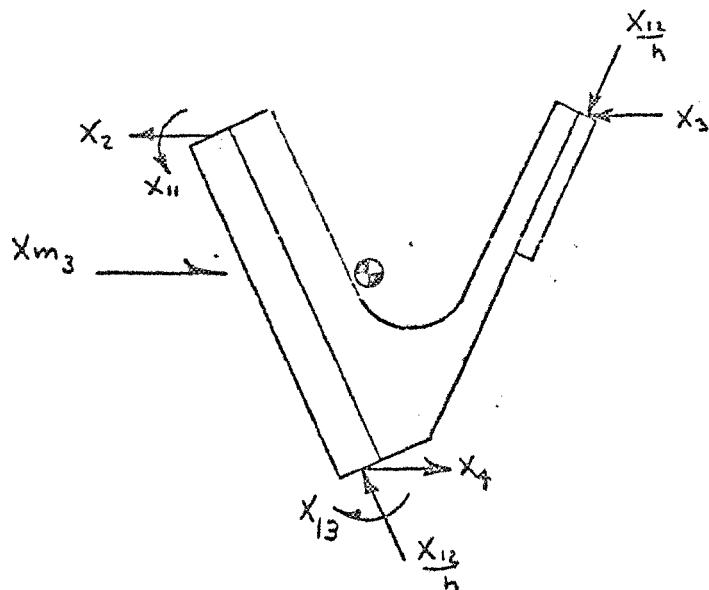
SM DIVISION
MODEL OSV-4
REPORT NO. SM 42569

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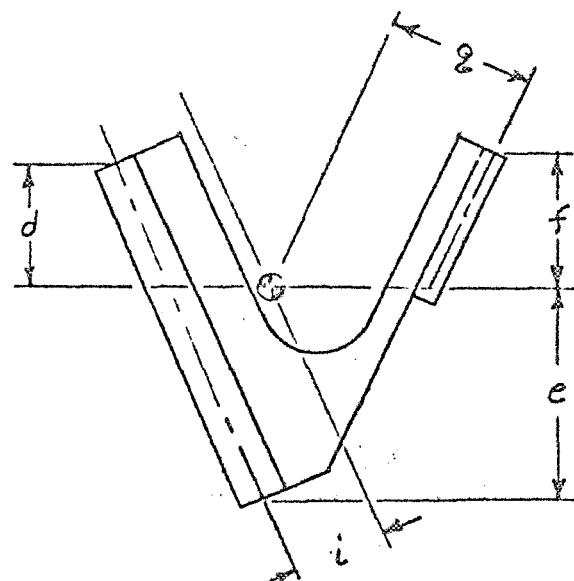
ASSY , AFT

5863804 TANK
ASSY , AFT

PART 3 RING



$$\begin{aligned}I_3 &= .535 \\A &= 1.701 \\d &= .89 \\e &= 1.08 \\f &= .96 \\g &= .72 \\L &= .50\end{aligned}$$



PREPARED BY: G.P.H.
CHECKED BY: G.J.S.
DATE: 11/2
TITLE: D-11-1 REPELLANT TANK

DOUGLAS AIRCRAFT COMPANY, INC.

SM

DIVISION

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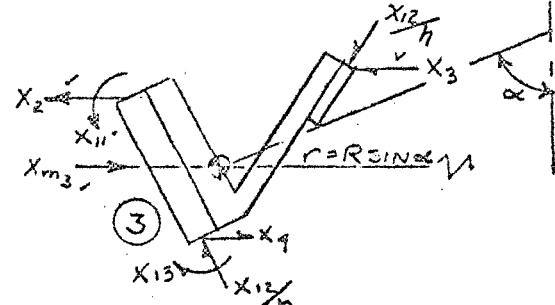
MODEL: DCV-4

REPORT NO: SM 42567

PART 3 RING.

5863804 TANK
ASSY, AFT

$$r = R \sin \alpha \quad \phi = 90^\circ - \alpha$$



$$\delta_{2,2}^3 = \frac{x_2 r^2}{E_3 A_3} + \frac{x_2 d^2 r^2}{E_3 I_3}$$

$$\delta_{2,3}^3 = \frac{x_3 r^2}{E_3 A_3} + \frac{x_3 d^2 r^2}{E_3 I_3}$$

$$\delta_{2,4}^3 = -\frac{x_4 r^2}{E_3 A_3} + \frac{x_4 d^2 r^2}{E_3 I_3}$$

$$\delta_{2,11}^3 = \frac{x_{11} d^2 r^2}{E_3 I_3}$$

$$\delta_{2,12}^3 = \frac{2x_{12} \sin \phi r^2}{h E_3 A_3} - \frac{x_{12} d^2 r^2}{h E_3 I_3} - \frac{x_{12} d^2 r^2}{h E_3 I_3}$$

$$\delta_{2,13}^3 = -\frac{x_{13} d^2 r^2}{E_3 I_3}$$

$$\delta_{2,T_3}^3 = \alpha \Delta T_3 \sin \phi R$$

$$\delta_{2,m}^3 = -\frac{x_{m_3} r^2}{E_3 A_3}$$

$$\delta_{3,2}^3 = \frac{x_2 r^2}{E_3 A_3} + \frac{x_2 d^2 r^2}{E_3 I_3}$$

$$\delta_{3,3}^3 = \frac{x_3 r^2}{E_3 A_3} + \frac{x_3 d^2 r^2}{E_3 I_3}$$

PREPARED BY S.R.H.
CHECKED BY G.J.S.
DATE 11/17
TITLE F-87-A PROPELANT TANK

DOUGLAS AIRCRAFT COMPANY, INC.

SM

DIVISION

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MODEL DSV-4

REPORT NO. 19642569

PART 3 RING

5863804 TANK
ASSY , AFT

$$\delta_{3,4}^3 = \frac{x_4 r^2}{E_3 A_3} + \frac{x_4 e s r^2}{E_3 I_3}$$

$$\delta_{3,11}^3 = \frac{x_{11} f' r^2}{E_3 I_3}$$

$$\delta_{3,12}^3 = + \frac{\bar{e} x_{12} \sin \phi' r^2}{h E_3 A_3} - \frac{x_{12} f g' r^2}{h E_3 I_3} - \frac{x_{12} f' c' r^2}{h E_3 I_3}$$

$$\delta_{3,13}^3 = - \frac{x_{13} f' r^2}{E_3 I_3}$$

$$\delta_{3,73}^3 = + \alpha \Delta T_3 r$$

$$\delta_{3,m}^3 = - \frac{x_{m3} r^2}{E_3 A_3}$$

$$\delta_{4,2}^3 = \frac{x_2 r^2}{E_3 A_3} + \frac{x_2 d' e' r^2}{E_3 I_3}$$

$$\delta_{4,3}^3 = \frac{x_3 r^2}{E_3 A_3} + \frac{x_3 e' f' r^2}{E_3 I_3}$$

$$\delta_{4,4}^3 = + \frac{x_4 r^2}{E_3 A_3} + \frac{x_4 e' z' r^2}{E_3 I_3}$$

$$\delta_{4,11}^3 = \frac{x_{11} e' r^2}{E_3 I_3}$$

PREPARED BY: R.R.H.
CHECKED BY: G.T.S.
DATE: 11/22
TITLE: DSV-4 PIGMENT TANK

BOEING AIRCRAFT COMPANY, INC.

SM

DIVISION

PAGE: III, G, 7
MODEL: DSV-4
REPORT NO: SH 42560

PART 3 RING

5863804 TANK
ASSY, AFT

$$\delta_{4,2}^3 = -\frac{2x_{12}\sin\phi r^2}{h'E_3'A_3} - \frac{x_{12}g'er^2}{h'E_3'I_3} - \frac{x_{12}e'c'r^2}{h'E_3'I_3}$$

$$\delta_{4,13}^3 = -\frac{x_{13}e'r^2}{E_3'I_3}$$

$$\delta_{4,T_3}^3 = -2\Delta T_3 r'$$

$$\delta_{4,m}^3 = +\frac{x_{m3}r^2}{E_3A_3}$$

$$\delta_{11,2}^3 = \frac{x_2d'r^2}{E_3I_3}$$

$$\delta_{11,3}^3 = \frac{x_3f'r^2}{E_3I_3}$$

$$\delta_{11,4}^3 = \frac{x_4e'r^2}{E_3I_3}$$

$$\delta_{11,11}^3 = \frac{x_{11}r^2}{E_3I_3}$$

$$\delta_{11,12}^3 = -\frac{x_{12}g'r^2}{h'E_3I_3} - \frac{x_{12}e'r^2}{h'E_3I_3}$$

$$\delta_{11,13}^3 = -\frac{x_{13}r^2}{E_3I_3}$$

$$\delta_{11,T_3}^3 = 0$$

PREPARED BY J.R.H.
CHECKED BY G.W.S.
DATE 1/12/62

DOUGLAS AIRCRAFT COMPANY, INC.

SM

DIVISION

PAGE III, 6, 8MODEL DSV-4REPORT NO. SM 425 R 9TITLE DSV-4 PROPELLANT TANK

PART 3 RING

5863804 TANK
ASSY, AFT

$$\mathcal{S}_{12,2}^3 = \frac{x_2' r^2 \sin \phi}{h' A_3' E_3'} - \frac{x_2' d_2' r^2}{h' E_3' I_3'} + \frac{x_2' r^2 \sin \phi}{h' A_3' E_3'} - \frac{x_2' d_2' r^2}{h' I_3' E_3'}$$

$$\mathcal{S}_{12,3}^3 = \frac{2x_3' r^2 \sin \phi}{h' A_3' E_3'} - \frac{x_3' f_8' r^2}{h' E_3' I_3'} - \frac{x_3' f_6' r^2}{h' E_3' I_3'}$$

$$\mathcal{S}_{12,4}^3 = -2x_4' r^2 \sin \phi - \frac{x_4' e_8' r^2}{h' E_3' I_3'} - \frac{x_4' e_6' r^2}{h' E_3' I_3'}$$

$$\mathcal{S}_{12,11}^3 = -\frac{x_{11}' r^2 g}{h' E_3' I_3'} - \frac{x_{11}' r^2 l}{h' E_3' I_3'}$$

$$\mathcal{S}_{12,12}^3 = \frac{x_{12}' z' r^2 \sin^2 \phi}{h' E_3' A_3'} + \frac{z' r^2}{E_3' I_3'} \left(\frac{x_{12}' g}{h} + \frac{x_{12}' l}{h} \right)^2 + \frac{z' r^2}{E_3' I_3'} \left(\frac{x_{12}' g}{h} + \frac{x_{12}' l}{h} \right)^2$$

$$\mathcal{S}_{12,13}^3 = \frac{x_{13}' r^2 g}{h' E_3' I_3'} + \frac{x_{13}' r^2 l}{h' E_3' I_3'}$$

$$\mathcal{S}_{12,T}^3 = x_3' \Delta T_3' r' \sin \phi v$$

$$\mathcal{S}_{12,m}^3 = -2x_m' r^2 \sin \phi$$

PREPARED BY GRI
CHECKED BY G. J. S.
DATE 1/12/62
TITLE DSV-1 RECELLANT TANK

DOUGLAS AIRCRAFT COMPANY, INC.

SM

DIVISION

PAGE III.6.9MOZL DSV-4REPORT NO. SM 425 E 9

PART 3 RING

5863804 TANK
ASSY, AFT

$$\delta_{13,2}^3 = -\frac{x_2' dr^2}{E_3' I_3'}$$

$$\delta_{13,3}^3 = -\frac{x_3' fr^2}{E_3' I_3'}$$

$$\delta_{13,4}^3 = -\frac{x_4' er^2}{E_3' I_3'}$$

$$\delta_{13,11}^3 = -\frac{x_{11}' r^2}{E_3' I_3'}$$

$$\delta_{13,13}^3 = \frac{x_{13}' r^2}{E_3' I_3'}$$

$$\delta_{13,r}^3 = 0$$

$$\delta_{13,12}^3 = \frac{x_{12}' r^2}{h E_3' I_3'} (g + l)$$

PREPARED BY C.R.H.
CHECKED BY G.J.S.
DATE 1/17/62
TITLE FIG. 4 - EXPELLANT TANK

DEPARTING AUTOMATIC COMPUTING ENGINE

SM

DIVISION

PAGE III-6-10

MODEL OSV-4

REPORT NO. SM 4-56-9

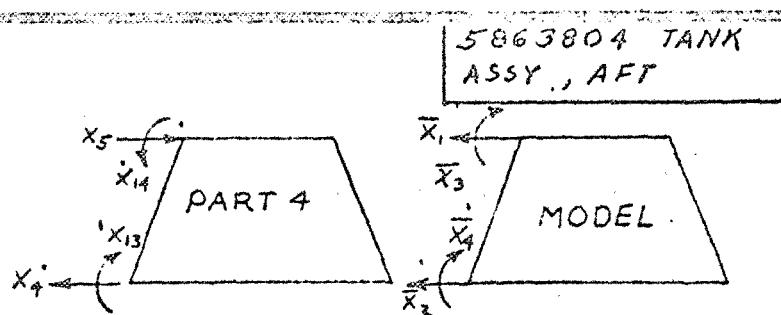
PART 4 CONE

$$X_4 = \bar{X}_2$$

$$X_5 = -\bar{X}_1$$

$$X_{13} = \bar{X}_4$$

$$X_{14} = -\bar{X}_3$$



$$\delta_{4,4}^4 = + \bar{\delta}_{2,2}^4$$

$$\delta_{4,5}^4 = - \bar{\delta}_{2,1}^4$$

$$\delta_{4,13}^4 = + \bar{\delta}_{2,4}^4$$

$$\delta_{4,14}^4 = - \bar{\delta}_{2,3}^4$$

$$\delta_{4,T}^4 = \alpha \Delta T_4 R \sin \alpha$$

$$\delta_{5,4}^4 = - \bar{\delta}_{1,2}^4$$

$$\delta_{5,5}^4 = + \bar{\delta}_{1,1}^4$$

$$\delta_{5,13}^4 = - \bar{\delta}_{1,4}^4$$

$$\delta_{5,14}^4 = + \bar{\delta}_{1,3}^4$$

$$\delta_{5,T}^4 = - \alpha \Delta T_4 R \sin \alpha$$

$$\delta_{13,4}^4 = + \bar{\delta}_{4,2}^4$$

$$\delta_{13,5}^4 = - \bar{\delta}_{4,1}^4$$

$$\delta_{13,13}^4 = + \bar{\delta}_{4,4}^4$$

$$\delta_{13,14}^4 = - \bar{\delta}_{4,3}^4$$

$$\delta_{13,T}^4 = 0$$

$$\delta_{14,4}^4 = - \bar{\delta}_{3,2}^4$$

$$\delta_{14,5}^4 = + \bar{\delta}_{3,1}^4$$

$$\delta_{14,13}^4 = - \bar{\delta}_{3,4}^4$$

$$\delta_{14,14}^4 = + \bar{\delta}_{3,3}^4$$

$$\delta_{14,T}^4 = 0$$

4-20-67
V. 2-02

PREPARED BY: G.R.J.
CHECKED BY: G. J. S.
DATE: 11/62
TITLE: DSV-1 PROPELLANT TANK

ESTABLISH AIRCRAFT COMPANY, INC.

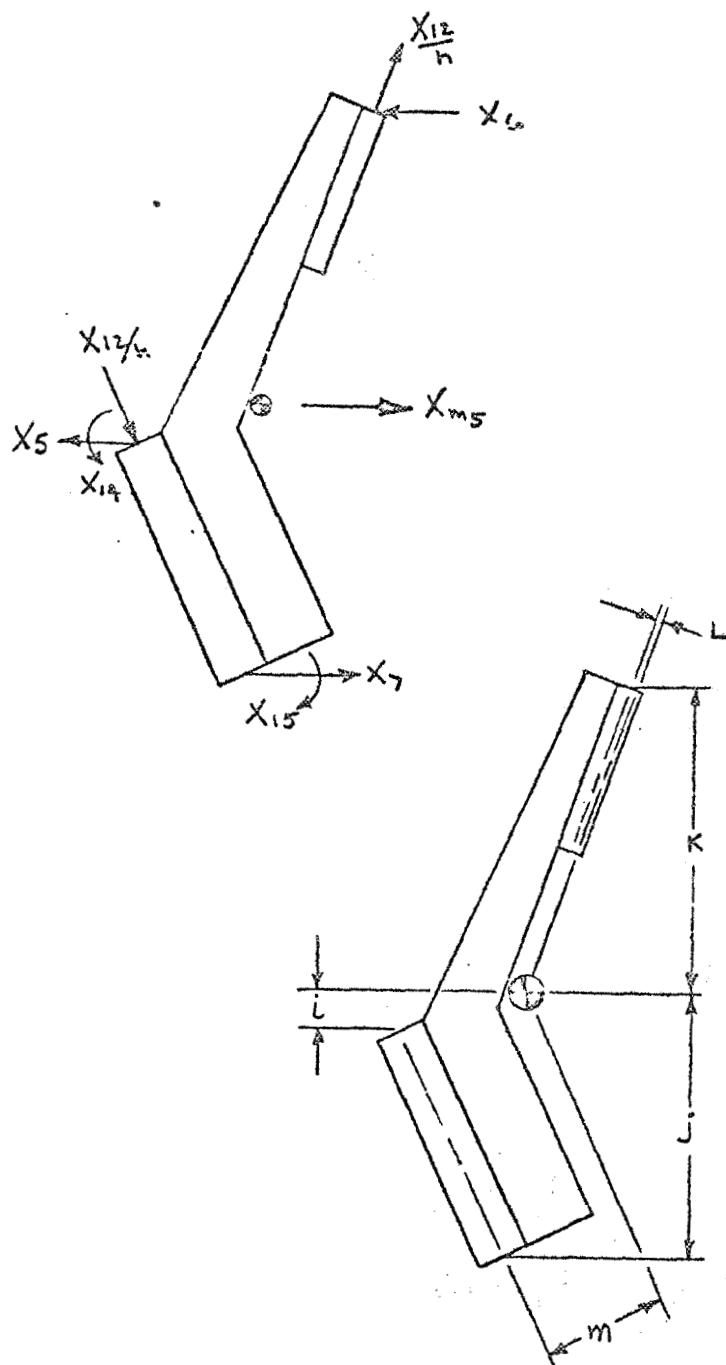
SM

DIVISION

PAGE: III-6.11
MODEL: DSV-1
REPORT NO: SII 42569

PART 5 RING

5863804 TANK
ASSY, AFT



$$I = 1.186$$

$$A = 1.523$$

$$L = .07$$

$$j = 1.36$$

$$K = 1.81$$

$$L = .14$$

$$m = .67$$

PREPARED BY GPH
CHECKED BY G. J. S.
DATE 1/2/68
TITLE DSV-4 PROPELLANT TANK

DOUGLAS AEROSPACE COMPANY, INC.

SM

DIVISION

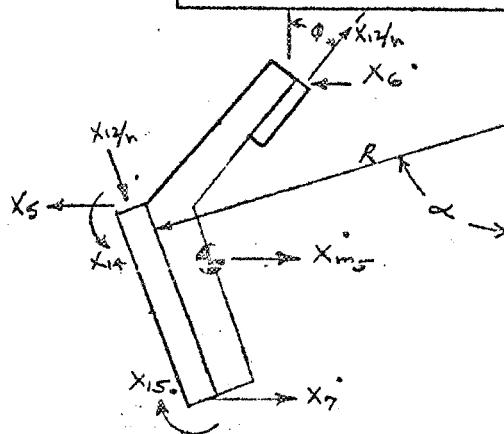
PAGE III.6.12

MODEL DSV-4

REPORT NO. SM 42560

PART 5 RING

5863804 TANK
ASSY, AFT



$$S_{5,5}^5 = \frac{x_5 r^2}{E_s A_s} + \frac{x_5 l^2 r^2}{E_s I_s}$$

$$S_{5,6}^5 = \frac{x_6 r^2}{E_s A_s} - \frac{x_6 k i r^2}{E_s I_s}$$

$$S_{5,7}^5 = -\frac{x_7 r^2}{E_s A_s} - \frac{x_7 i j r^2}{E_s I_s}$$

$$S_{5,12}^5 = -\frac{2x_{12} \sin \phi r^2}{h \cdot E_s A_s} + \frac{x_{12} i l r^2}{h \cdot E_s I_s} - \frac{x_{12} l i m r^2}{h \cdot E_s I_s}$$

$$S_{5,14}^5 = -\frac{x_{14} l i r^2}{E_s I_s}$$

$$S_{5,15}^5 = \frac{x_{15} r^2 i}{E_s I_s}$$

$$\delta_{5,T_5}^5 = \Delta T_5 R \sin \alpha$$

$$S_{5,M}^5 = -\frac{x_m r^2}{E_s A_s}$$

$$S_{6,5}^5 = +\frac{x_5 r^2}{E_s A_s} - \frac{x_5 k i r^2}{E_s I_s}$$

$$S_{6,6}^5 = +\frac{x_6 r^2}{E_s A_s} + \frac{x_6 k^2 r^2}{E_s I_s}$$

$$S_{6,7}^5 = -\frac{x_7 r^2}{E_s A_s} + \frac{x_7 i k r^2}{E_s I_s}$$

PREPARED BY G.R.H.
CHECKED BY G.W.S.
DATE 1/13/62
TITLE DSV-4 PROPELLANT TANK

BUELLS AIRCRAFT COMPANY, INC.

SM

DIVISION

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MODEL DSV-4

REPORT NO. SM 42569

PART 5 RING

5863804 TANK
ASSY, AFT

$$\delta_{6,12}^5 = \frac{-2x_{12}\sin\phi r^2}{hE_s A_s} - \frac{x_{12}j'kr^2}{hE_s I_s} + \frac{x_{12}kimr^2}{hE_s I_s}$$

$$\delta_{6,14}^5 = \frac{x_{14}k'r^2}{E_s I_s}$$

$$\delta_{6,15}^5 = -\frac{x_{15}k'r^2}{E_s I_s}$$

$$\delta_{6,T}^5 = +x_5 \Delta T_s R \sin\alpha$$

$$\delta_{6,m}^5 = -\frac{x_{m5}r^2}{E_s A_s}$$

$$\delta_{7,5}^5 = -\frac{x_5r^2}{E_s A_s} - \frac{x_5Lj'r^2}{E_s I_s}$$

$$\delta_{7,6}^5 = -\frac{x_6r^2}{E_s A_s} + \frac{x_6j'kr^2}{E_s I_s}$$

$$\delta_{7,7}^5 = \frac{x_7r^2}{E_s A_s} + \frac{x_7j^2r^2}{E_s I_s}$$

$$\delta_{7,12}^5 = \frac{2x_{12}\sin\phi r^2}{hE_s A_s} - \frac{x_{12}j'kr^2}{hE_s I_s} + \frac{x_{12}simr^2}{hE_s I_s}$$

$$\delta_{7,14}^5 = \frac{x_{14}j'r^2}{E_s I_s}$$

$$\delta_{7,15}^5 = -\frac{x_{15}j'r^2}{E_s I_s}$$

$$\delta_{7,T}^5 = -\Delta T_s R \sin\alpha$$

$$\delta_{7,m}^5 = \frac{x_{m7}r^2}{E_s A_s}$$

PREPARED BY CPH
CHECKED BY GTS
DATE 1/13/62
TITLE DSV-4 PACIFICANT TANK

BOEING AIRCRAFT COMPANY, INC.

SM

DIVISION

PAGE III.6.14

MODEL DSV-4

REPORT NO. SN 42559

PART 5 RING

5863804 TANK
ASSY, AFT

$$S_{12,5}^5 = -\frac{z x_5 r^2 \sin \phi}{h E_s A_s} + \frac{x_5 i l r^2}{h E_s I_s} - \frac{x_5 m i r^2}{h E_s I_s}$$

$$S_{12,6}^5 = -\frac{z x_6 r^2 \sin \phi}{h E_s A_s} - \frac{x_6 k l r^2}{h E_s I_s} + \frac{x_6 k m i r^2}{h E_s I_s}$$

$$S_{12,7}^5 = -\frac{z x_7 r^2 \sin \phi}{h E_s A_s} - \frac{x_7 j l r^2}{h E_s I_s} + \frac{x_7 j m i r^2}{h E_s I_s}$$

$$S_{12,12}^5 = \frac{z x_{12} r^2 \sin^2 \phi}{h E_s A_s} + \left(\frac{x_{12} l}{h} - \frac{x_{12} m}{h} \right) \frac{l r^2}{E_s I_s} + \left(\frac{x_{12} m}{h} - \frac{x_{12} l}{h} \right) \frac{m r^2}{E_s I_s}$$

$$S_{12,14}^5 = -\frac{x_{14} l r^2}{h E_s I_s} + \frac{x_{14} m i r^2}{h E_s I_s}$$

$$S_{12,15}^5 = \frac{x_{15} l r^2}{h E_s I_s} - \frac{x_{15} m i r^2}{h E_s I_s}$$

$$S_{12,7}^5 = -x_5 \Delta T_5 r \sin \phi$$

$$S_{12,m}^5 = \frac{z x_m r^2 \sin \phi}{h E_s A_s}$$

$$S_{14,5}^5 = \frac{-x_5 l r^2}{E_s I_s}$$

$$S_{14,6}^5 = \frac{x_6 k r^2}{E_s I_s}$$

$$S_{14,7}^5 = \frac{x_7 j r^2}{E_s I_s}$$

PREPARED BY: G.R.H.
CHECKED BY: G.J.S.
DATE: 11/21/62
TITLE: D51-4 PROPELLENT TANK

DODGEING AERONAUTIC COMPANY, INC.

SM

DIVISION

PAGE: III. 6.15
MODEL: DSV-4
REPORT NO.: 5M 615 S 3

PART 5: RING

5863804 TANK
ASSY, AFT

$$\delta_{14,12}^5 = -\frac{x_{12} l' r^2}{h E_s I_s} + \frac{x_{12} m r^2}{h' E_s' I_s'}$$

$$\delta_{14,14}^5 = \frac{x_{14} r^2}{E_s I_s}$$

$$\delta_{14,15}^5 = -\frac{x_{15} r^2}{E_s' I_s'}$$

$$\delta_{14,T}^5 = 0$$

$$\delta_{15,5}^5 = \frac{x_5 l' r^2}{E_s I_s}$$

$$\delta_{15,6}^5 = -\frac{x_6 k' r^2}{E_s' I_s'}$$

$$\delta_{15,7}^5 = -\frac{x_7 j' r^2}{E_s' I_s'}$$

$$\delta_{15,12}^5 = \frac{x_{12} l' r^2}{h E_s I_s} - \frac{x_{12} m r^2}{h' E_s' I_s'}$$

$$\delta_{15,14}^5 = -\frac{x_{14} r^2}{E_s I_s}$$

$$\delta_{15,15}^5 = \frac{x_{15} r^2}{E_s' I_s'}$$

$$\delta_{15,T}^5 = 0$$

PREPARED BY: S.R.H.
CHECKED BY: G.J.S.
DATE: 7/6/62
TITLE: DSV-4 PROPELLANT TANK

DOUGLAS AIRCRAFT COMPANY, INC.

SM

DIVISION

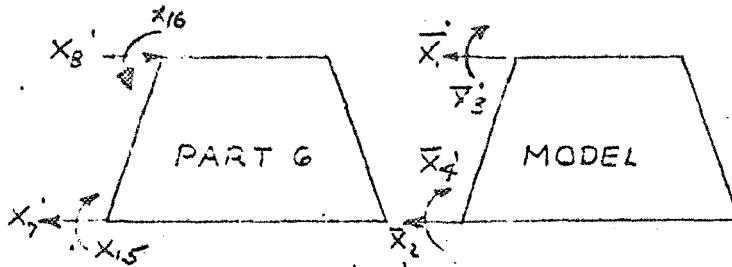
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MODEL: DSV-4

REPORT NO. SM 4 - 689

PART 6 CONE

$$\begin{aligned}x_7 &= \bar{x}_2 \\x_8 &= -\bar{x}_1 \\x_{15} &= \bar{x}_9 \\x_{16} &= -\bar{x}_3\end{aligned}$$



$$\delta_{7,7}^6 = + \bar{\delta}_{2,2}^6$$

$$\delta_{7,8}^6 = - \bar{\delta}_{2,1}^6$$

$$\delta_{7,15}^6 = + \bar{\delta}_{2,4}^6$$

$$\delta_{7,16}^6 = - \bar{\delta}_{2,3}^6$$

$$\delta_{7,T}^6 = \alpha \Delta T_6 R \sin \alpha$$

$$\delta_{7,P}^6 = \frac{F_6 R (1 - \nu) R \sin \alpha}{2 E_6 t_6}$$

$$\delta_{8,7}^6 = - \bar{\delta}_{1,2}^6$$

$$\delta_{8,8}^6 = + \bar{\delta}_{1,1}^6$$

$$\delta_{8,15}^6 = - \bar{\delta}_{1,4}^6$$

$$\delta_{8,16}^6 = + \bar{\delta}_{1,3}^6$$

$$\delta_{8,T}^6 = - \alpha \Delta T_6 R \sin \alpha$$

$$\delta_{8,P}^6 = \frac{-P_e i c (1 - \nu) R \sin \alpha}{2 E_6 t_6}$$

$$\delta_{15,7}^6 = + \bar{\delta}_{4,2}^6$$

$$\delta_{15,8}^6 = - \bar{\delta}_{4,1}^6$$

$$\delta_{15,15}^6 = + \bar{\delta}_{4,4}^6$$

$$\delta_{15,16}^6 = - \bar{\delta}_{4,3}^6$$

$$\delta_{15,T}^6 = 0$$

$$\delta_{15,P}^6 = 0$$

$$\delta_{16,7}^6 = - \bar{\delta}_{3,2}^6$$

$$\delta_{16,8}^6 = + \bar{\delta}_{3,1}^6$$

$$\delta_{16,15}^6 = - \bar{\delta}_{3,4}^6$$

$$\delta_{16,16}^6 = + \bar{\delta}_{3,3}^6$$

$$\delta_{16,T}^6 = 0$$

$$\delta_{16,P}^6 = 0$$

PREPARED BY: CARL H.
 CHECKED BY: G. J. S.
 DATE: 11/2/62
 TITLE: DSV-4 PROPELLANT TANK

DOUGLAS AIRCRAFT COMPANY, INC.

SM

DIVISION

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MODEL DSV-4

REPORT NO. SM 42569

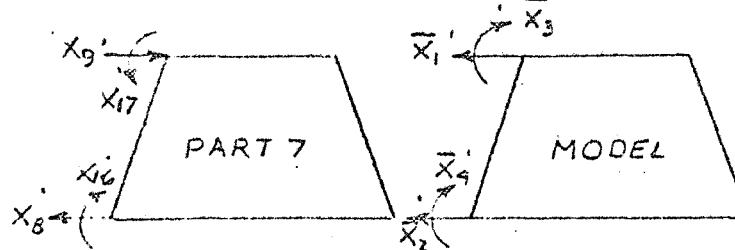
PART 7 CONE

$$x_8 = + \bar{x}_2$$

$$x_9 = - \bar{x}_1$$

$$x_{16} = + \bar{x}_4$$

$$x_{17} = - \bar{x}_3$$



5863804 TANK
ASSY, AFT

$$\delta_{8,8}^7 = + \bar{\delta}_{2,2}$$

$$\delta_{8,9}^7 = - \bar{\delta}_{2,1}$$

$$\delta_{8,16}^7 = + \bar{\delta}_{2,4}$$

$$\delta_{8,17}^7 = - \bar{\delta}_{2,3}$$

$$\delta_{8,T}^7 = \alpha \Delta T, R \sin \alpha$$

$$\delta_{8,P}^7 = \frac{PR(1-\nu)R \sin \alpha}{2'E_7 t_7}$$

$$\delta_{9,8}^7 = - \bar{\delta}_{1,2}$$

$$\delta_{9,9}^7 = + \bar{\delta}_{1,1}$$

$$\delta_{9,16}^7 = - \bar{\delta}_{1,4}$$

$$\delta_{9,17}^7 = + \bar{\delta}_{1,3}$$

$$\delta_{9,T}^7 = - \alpha \Delta T, R \sin \alpha$$

$$\delta_{9,P}^7 = - \frac{PR(1-\nu)R \sin \alpha}{2'E_7 t_7}$$

$$\delta_{16,8}^7 = + \bar{\delta}_{4,2}$$

$$\delta_{16,9}^7 = - \bar{\delta}_{4,1}$$

$$\delta_{16,16}^7 = + \bar{\delta}_{4,4}$$

$$\delta_{16,17}^7 = - \bar{\delta}_{4,3}$$

$$\delta_{16,T}^7 = 0$$

$$\delta_{16,P}^7 = 0$$

$$\delta_{17,8}^7 = - \bar{\delta}_{3,2}$$

$$\delta_{17,9}^7 = + \bar{\delta}_{3,1}$$

$$\delta_{17,16}^7 = - \bar{\delta}_{3,4}$$

$$\delta_{17,17}^7 = + \bar{\delta}_{3,3}$$

$$\delta_{17,T}^7 = 0$$

$$\delta_{17,P}^7 = 0$$

PREPARED BY G.P.H.
 CHECKED BY G.D.S.
 DATE 1/62
 TITLE DSV-4 PARALLEL TANK

ESUCIAS AIRCRAFT COMPANY, INC.

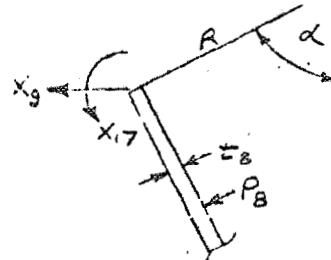
SEM

DIVISION

PAGE III. 6.1B
 MODEL DSV-4
 REPORT NO. SM 42569

PART 8

5863804 TANK
 ASSY, AFT



$$\lambda_B = \sqrt{3(1-v^2) \left(\frac{R}{\epsilon_B}\right)^2}$$

$$K_1 = 1 - \frac{1-2v}{2\lambda} \cot x$$

$$K_2 = 1 - \frac{1-2v}{2\lambda} \csc x$$

$$C_{9,9}^E = \frac{x_q R \lambda_B \sin^2 x \left(\frac{1}{K_1} + K_2 \right)}{E_B t_B s'}$$

$$S_{9,17}^E = \frac{x_q 2 \lambda_B^2 \sin x}{E_B t_B K_1}$$

$$S_{9,T}^E = \alpha \Delta T_B R \sin x$$

$$S_{9,P}^E = \frac{P_B R^2 (1-v)}{2 E_B t_B} \sin x$$

$$S_{17,9}^E = \frac{x_q 2 \lambda_B^2 \sin x}{E_B t_B K_1} = S_{9,17}^E$$

$$S_{17,17}^E = \frac{4 \lambda_B^3 x_q}{E_B t_B R K_1}$$

$$S_{17,P_B}^E = S_{17,T_B}^E = 0$$

PREPARED BY SRH
 CHECKED BY G.J.S.
 DATE 11/21/68
 TITLE DSV-4 PROPELLANT TANK

BENDIX AIRCRAFT COMPANY, INC.

SM

DIVISION

PAGE III, 6.0

MODEL DSV-4

REPORT NO. 6X425F9

PART 9

$$\Sigma = + (\alpha_A \Delta T_A - \alpha_e \Delta T_e) - \frac{h}{R} \dot{x} c t_c$$

$$= \frac{R}{2} \left(\frac{1}{\epsilon_A E_A} + \frac{1}{\epsilon_e E_e} \right) (1 - \dot{\nu}) + \frac{h}{E_c R}$$

$$h = \frac{\epsilon_A + \epsilon_e}{2} + t_c$$

$$N_{12} = \frac{\Sigma R'}{2} ; M_d = -N_{12} h'$$

$$\lambda_F = 1 - \nu_F^{-2}$$

$$E_F = \frac{\epsilon_A E_A + \epsilon_e E_e}{\epsilon_A + \epsilon_e} ; H = E_F (t - t_c)$$

$$D = \frac{E_F t_f t_{f_2} (t + t_c)^2}{4 \lambda_F (t - t_c)} = \frac{E_F (t_c)^3}{12 \lambda_F}$$

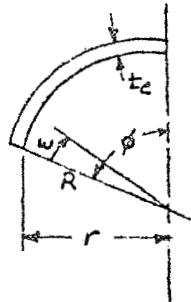
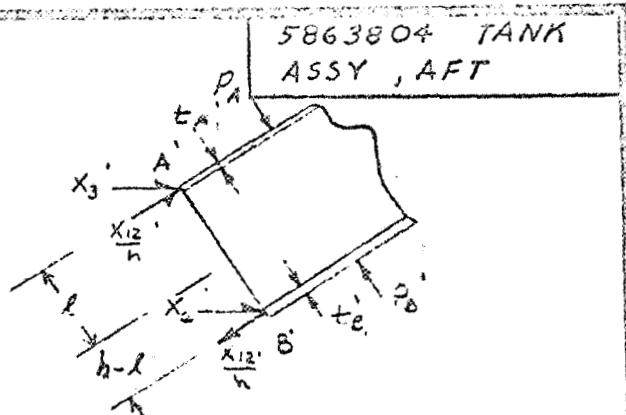
$$t_c = \sqrt[3]{\frac{3 t_f t_{f_2} (t + t_c)^2}{t - t_c}}$$

$$B = \sqrt[4]{3(1-\nu^2)(\frac{R}{t_c})^2}$$

$$K_1 = 1 - \frac{1-2\nu^2}{2B} \cot(\phi - \omega)$$

$$K_2 = 1 - \frac{1-2\nu^2}{2B} \cot(\phi + \omega)$$

$$\lambda = \sqrt[4]{\frac{3(1-\nu^2)}{R^2 t_c^2}}$$



$$\delta_{3,3}^9 = \frac{x_3}{E_F t_c} B R \sin^2 \phi \left(K_2 + \frac{1}{K_1} \right)$$

$$\delta_{3,6}^9 = \frac{x_6}{E_F t_c} B R \sin^2 \phi \left(K_2 + \frac{1}{K_1} \right)$$

$$\delta_{3,12}^9 = - \frac{x_{12}}{E_F t_c} \left(\frac{2 B^2 \sin \phi}{K_1} \right) + \frac{x_{12} l \cos \phi}{E_F t_c} \left(\frac{4 B^3}{R K_1} \right)$$

PREPARED BY CCH
CHECKED BY G.J.S.
DATE 1/15/62
TITLE DSV-4 PROPULSION TANK

BOEING AIRCRAFT COMPANY, INC.

SM

DIVISION

PAGE JIL 6.20MODEL DSV-4REPORT NO. SH42569PART 958638.04 TANK
ASSY, AFT

$$\delta_{3,T}^9 = -r \frac{x \Delta t_A E_A + x \Delta t_E E_E}{\Delta t_A + \Delta t_E}$$

$$\delta_{3,P}^9 = -\frac{\rho R^2 (1-\nu)}{2 E_F t_F} \sin \phi = -\delta_{3,P_A}^9$$

$$\delta_{6,3}^9 = \delta_{3,6}^9$$

$$\delta_{6,6}^9 = \frac{x_6}{E_F t_F} B R \sin^2 \phi \left(K_2 + \frac{1}{K_1} \right)$$

$$\delta_{6,12}^9 = -\frac{x_{12}}{E_F t_F} \left(\frac{2 B^2 \sin^2 \phi}{K_1} \right) - \frac{x_{12}(h-f) \cos \phi}{E_F t_F} \left(\frac{4 B^3}{R K_1} \right)$$

$$\delta_{6,T}^9 = \delta_{3,T}^9$$

$$\delta_{6,P}^9 = \frac{\rho R^2 (1-\nu)}{2 E_F t_F} \sin \phi$$

$$\delta_{12,3}^9 = \delta_{3,12}^9$$

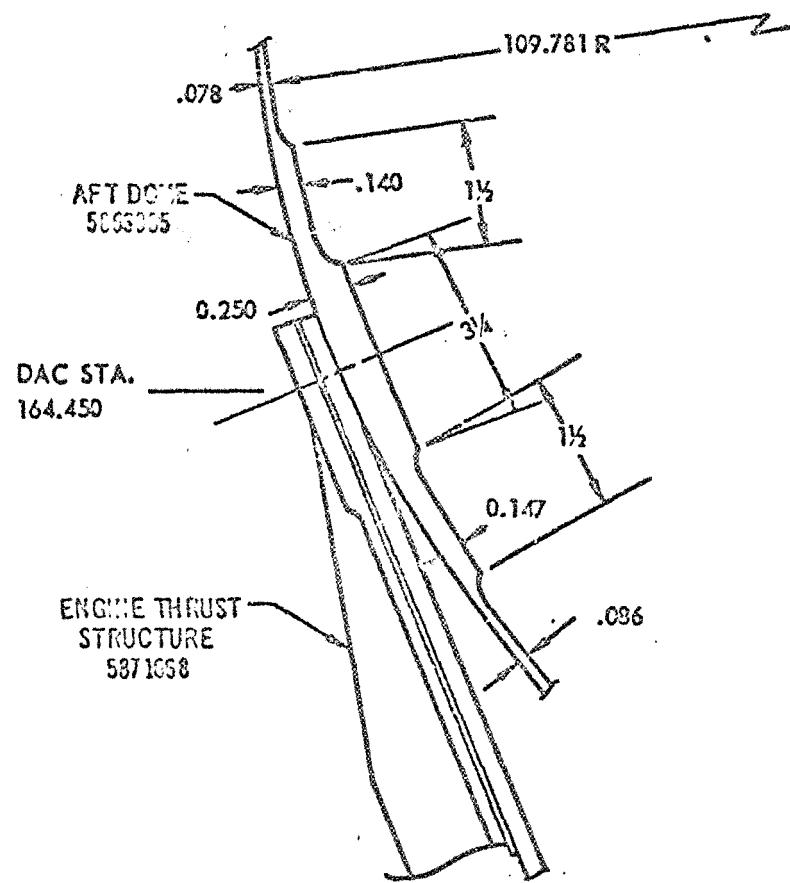
$$\delta_{12,6}^9 = \delta_{6,12}^9$$

$$\delta_{12,12}^9 = \frac{4 X_{12} B^3}{E_F t_F R K_1}$$

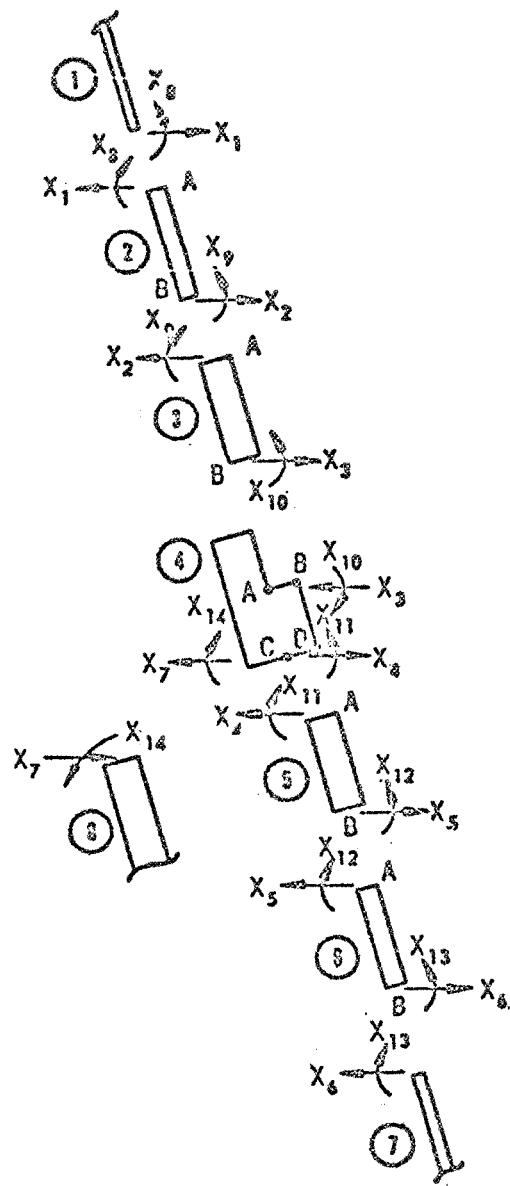
$$\delta_{12,T}^9 = \frac{M \phi}{E_F t_F} \left(\frac{4 B^3}{R K_1} \right)$$

$$\delta_{12,P}^9 = 0$$

THRUST STRUCTURE - AFT DOME JOINT
DISCONTINUITY ANALYSIS



AFT DOME-THRUST STRUCTURE JOINT



PREPARED BY K. P. H.
CHECKED BY G. L. S.
DATE 11/6/82
TITLE OSV-4 PROPELLANT TANK

BOEING AIRCRAFT COMPANY, INC.

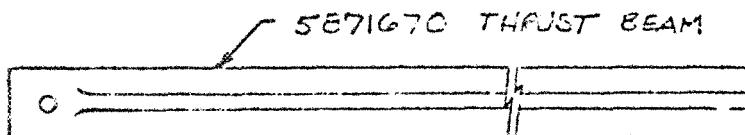
SM

DIVISION

PAGE III-7.2

MODEL OSV-4

REPORT NO. SM 42569

5871670 THRUST
STRUCTURE INST'L

$$I_{xx} = .0515'$$

$$L = 28.7'$$

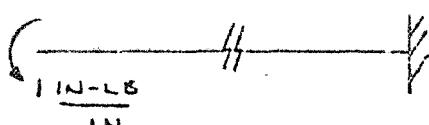
$$T = -298^\circ$$

$$E = 11.6(10^6)$$

$$\alpha \Delta T = -380(10^{-5})$$

$$\delta = \frac{w' L^3}{3EI} = \frac{28.7^3 \cdot 10^{-6}}{3(11.6)(.0515)} = 1.3190 \times 10^{-2}$$

$$\theta = \frac{28.7^2 (.5)}{11.6 (.0515) 10^6} = .0689 \times 10^{-2}$$



$$\theta = \frac{1(28.7)(10^{-6})}{11.6(.0515)} = .0048 \times 10^{-2}$$

$$\delta = \frac{28.7^2 (10^{-6})}{2(11.6)(.0515)} = .0689 \times 10^{-2}$$

M 29-84
IV. 8-88PREPARED BY G-RH

DOUGLAS AIRCRAFT COMPANY, INC.

CHECKED BY G. J. S.PAGE III. 7.3DATE 11/6/2SM

DIVISION

MODEL DSV-4TITLE DSV-4 PROPELLANT TANKREPORT NO. SM 42569PART I5871668 THRUST
STRUCTURE INSTL

$$S_{1,1}^i = \frac{x_1}{E't} \cdot B R \sin^2 \phi \left(K_2 + \frac{1}{K_1} \right)$$

$$S_{1,8}^i = \frac{x_8}{F't} \left(\frac{z'B^2 \sin \phi}{K_1} \right)$$

$$S_{1,T}^i = -\alpha_i \Delta t R \sin \phi$$

$$S_{1,P}^i = -\frac{PR^2(1-r) \sin \phi}{z'E't}$$

$$S_{8,1}^i = S_{1,8}^i$$

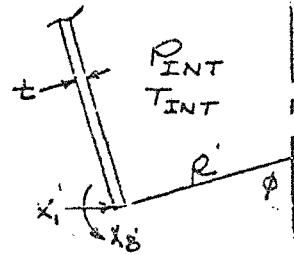
$$S_{8,8}^i = \frac{x_8}{E't} \left(\frac{4B^3}{RK_1} \right)$$

$$\phi = 56^\circ 27' ; R = 109.742$$

$$B = \left[3(1-m^2) \frac{R^2}{t^2} \right]^{1/4}$$

$$K_1 = 1 - \frac{1-z^2}{zB} \cot \phi$$

$$K_2 = 1 - \frac{1+z^2}{zB} \cot \phi$$



PREPARED BY KRH

DOUGLAS AIRCRAFT COMPANY, INC.

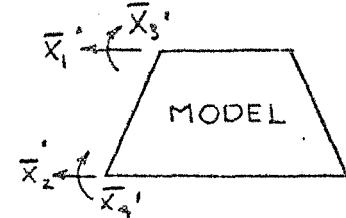
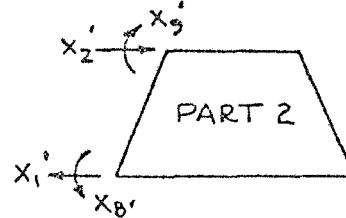
CHECKED BY G.J.S.PAGE III-7-4DATE 11/62

SM

DIVISION

MODEL DSV-4TITLE DSV-4 PROPELLANT TANKREPORT NO. SM 42560PART 2587,668 THRUST
STRUCTURE INSTL

$$\begin{aligned}x_1 &= +\bar{x}_2 \\x_2 &= -\bar{x}_1 \\x_3 &= -\bar{x}_4 \\x_9 &= +\bar{x}_3\end{aligned}$$



$$\delta_{1,1}^2 = +\bar{\delta}_{2,2}$$

$$\delta_{3,1}^2 = -\bar{\delta}_{4,2}$$

$$\delta_{1,2}^2 = -\bar{\delta}_{2,1}$$

$$\delta_{3,2}^2 = +\bar{\delta}_{4,1}$$

$$\delta_{1,3}^2 = -\bar{\delta}_{2,4}$$

$$\delta_{3,3}^2 = +\bar{\delta}_{4,4}$$

$$\delta_{1,4}^2 = +\bar{\delta}_{2,3}$$

$$\delta_{3,4}^2 = -\bar{\delta}_{4,3}$$

$$\delta_{1,p}^2 = \frac{PR^2(1-M)\sin\phi}{Z'Ez'}$$

$$\delta_{3,p}^2 = 0$$

$$\delta_{1,T}^2 = \alpha \Delta T R \sin\phi$$

$$\delta_{3,T}^2 = 0$$

$$\delta_{2,1}^2 = -\bar{\delta}_{1,2}$$

$$\delta_{3,1}^2 = +\bar{\delta}_{3,2}$$

$$\delta_{2,2}^2 = +\bar{\delta}_{1,1}$$

$$\delta_{3,2}^2 = -\bar{\delta}_{3,1}$$

$$\delta_{2,3}^2 = +\bar{\delta}_{1,4}$$

$$\delta_{3,3}^2 = -\bar{\delta}_{3,4}$$

$$\delta_{2,4}^2 = -\bar{\delta}_{1,3}$$

$$\delta_{3,4}^2 = +\bar{\delta}_{3,3}$$

$$\delta_{1,0}^2 = -\bar{\delta}_{1,p}$$

$$\delta_{3,p}^2 = 0$$

$$\delta_{2,T}^2 = -\bar{\delta}_{1,T}$$

$$\delta_{3,T}^2 = 0$$

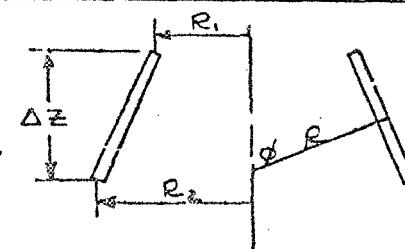
$$R_1 = 90.596'$$

$$R = 109.711'$$

$$R_2 = 91.433'$$

$$\phi = 56^\circ 41'$$

$$\Delta z = 1.245'$$



DOUGLAS AIRCRAFT COMPANY, INC.

PREPARED BY F.R.H.
CHECKED BY G.W.S.
DATE 11/16/67TITLE: SSV-4 PROPELLANT TANK

SM

DIVISION

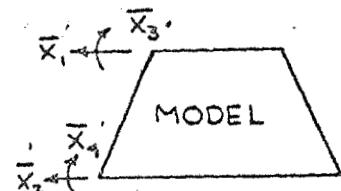
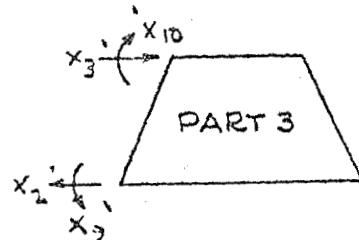
PAGE III. 7.5MODEL: DSV-4REPORT NO: 11425APART 35871668 THRUST
STRUCTURE INSTL

$$X_2 = + \bar{X}_2$$

$$X_3 = - \bar{X}_1$$

$$X_9 = - \bar{X}_4$$

$$X_{10} = + \bar{X}_3$$



$$\delta_{2,2}^3 = + \bar{\delta}_{2,2}$$

$$\delta_{2,3}^3 = - \bar{\delta}_{2,1}$$

$$\delta_{2,9}^3 = - \bar{\delta}_{2,4}$$

$$\delta_{2,10}^3 = + \bar{\delta}_{2,3}$$

$$\delta_{2,P}^3 + \frac{PR^2(1-\mu) \sin\phi}{2Et}$$

$$\delta_{2,T}^3 = + \alpha \Delta T R \sin\phi$$

$$\delta_{9,2}^3 = - \bar{\delta}_{9,2}$$

$$\delta_{9,3}^3 = + \bar{\delta}_{4,1}$$

$$\delta_{9,9}^3 = + \bar{\delta}_{4,4}$$

$$\delta_{9,10}^3 = - \bar{\delta}_{4,3}$$

$$\delta_{9,P}^3 = 0$$

$$\delta_{9,T}^3 = 0$$

$$\delta_{3,2}^3 = - \bar{\delta}_{1,2}$$

$$\delta_{3,3}^3 = + \bar{\delta}_{1,1}$$

$$\delta_{3,9}^3 = + \bar{\delta}_{1,4}$$

$$\delta_{3,10}^3 = - \bar{\delta}_{1,3}$$

$$\delta_{3,P}^3 = - \bar{\delta}_{2,P}$$

$$\delta_{3,T}^3 = - \bar{\delta}_{2,T}$$

$$\delta_{10,2}^3 = + \bar{\delta}_{3,2}$$

$$\delta_{10,3}^3 = - \bar{\delta}_{3,1}$$

$$\delta_{10,9}^3 = - \bar{\delta}_{3,4}$$

$$\delta_{10,10}^3 = + \bar{\delta}_{3,3}$$

$$\delta_{10,P}^3 = 0$$

$$\delta_{10,T}^3 = 0$$

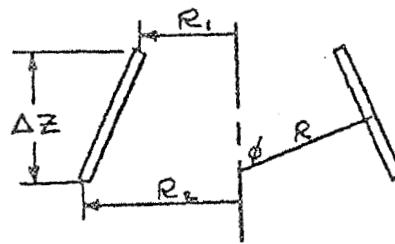
$$R = 109.656$$

$$\phi = 55^\circ 18'$$

$$R_1 = 89.668$$

$$R_2 = 90.447$$

$$\Delta Z = 1.117$$



PREPARED BY K-PH
CHECKED BY G.J.S.
DATE 11/6/2
TITLE DSV-4 PROPELLANT TANK

FORD MOTOR COMPANY, INC.

SM

DIVISION

PAGE III.7.6MODEL DSV-4REPORT NO. SH 42569PART 4SB71668 THRUST
STRUCTURE INSTL N^1 = THRUST LOAD N^2 = PRESSURE LOAD N^3 = RESULTANT

$$\alpha = .086$$

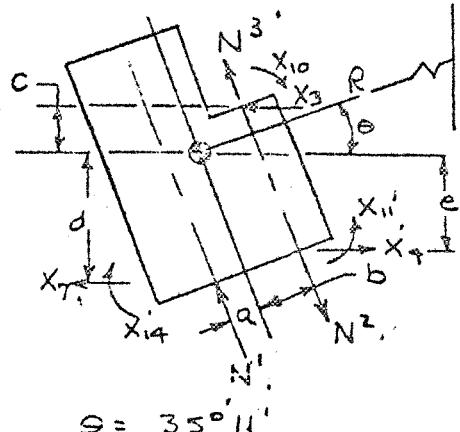
$$\beta = .217^\circ$$

$$\gamma = .219^\circ$$

$$\delta = .364$$

$$\epsilon = .189^\circ$$

$$r = R \cos 35^\circ 11' = 89.797^\circ$$



$$\delta_{3,3} = \left(\frac{r^2}{E \cdot A} + \frac{c^2 r^2}{E \cdot I} \right) x_3$$

$$\delta_{3,4} = \left(-\frac{r^2}{E \cdot A} + \frac{c' e r^2}{E \cdot I} \right) x_4$$

$$\delta_{3,T} = \alpha \Delta T \sin \theta$$

$$\delta_{3,7} = \left(+\frac{r^2}{E \cdot A} - \frac{c d r^2}{E \cdot I} \right) x_7$$

$$\delta_{3,10} = -\frac{c' r^2}{E \cdot I} x_{10}$$

$$\delta_{3,11} = +\frac{c' r^2}{E \cdot I} x_{11}$$

$$\delta_{3,14} = -\frac{c' r^2}{E \cdot I} x_{14}$$

$$\delta_{3,N^3} = \frac{N^3 \sin \theta r^2}{E \cdot A} + \frac{N^3 b c r^2}{E \cdot I}$$

$$\delta_{3,N^2} = \frac{N^2 \sin \theta r^2}{E \cdot A} - \frac{N^2 b c' r^2}{E \cdot I}$$

$$\delta_{3,N^1} = \frac{N^1 \sin \theta r^2}{E \cdot A} - \frac{N^1 a c' r^2}{E \cdot I}$$

PREPARED BY G.R.A.
CHECKED BY C.W.S.
DATE 11/62
TITLE DSV-4 PROPELLANT TANK

DODGE & DODGE INCORPORATED 1956

SM

DIVISION

PAGE III.7.7MODEL DSV-4REPORT NO. SM 425595871668 THRUST
STRUCTURE INSTL

$$\delta_{4,3} = \dot{\delta}_{3,4}$$

$$\delta_{4,4} = \left[\frac{r^2}{E'A} + \frac{e^2 r^2}{EI} \right] x_4$$

$$\delta_{4,7} = \left[-\frac{r^2}{E'A} - \frac{e^2 r^2}{EI} \right] x_7$$

$$\delta_{4,10} = -\frac{er^2}{EI} x_{10}$$

$$\delta_{4,11} = +\frac{er^2}{EI} x_{11}$$

$$\delta_{4,14} = -\frac{er^2}{EI} x_{14}$$

$$\delta_{4,N^3} = \frac{N^3 \sin \theta r^2}{E'A} + \frac{N^3 b e r^2}{EI}$$

$$\delta_{4,N^2} = +\frac{N^2 \sin \theta r^2}{E'A} - \frac{N^2 b e r^2}{EI}$$

$$\delta_{4,N'} = -\frac{N' \sin \theta r^2}{E'A} - \frac{N' b e r^2}{EI}$$

$$\delta_{4,T} = -\alpha \Delta T R \cos \theta$$

PREPARED BY G.R.H.
CHECKED BY G.J.S.
DATE 11/62
TITLE DSV-4 + DROPLESS TANK

GENERAL PLANT CO., INC.

SM

DIVISION

PAGE III. 7.8MODEL DSV-4REPORT NO. SM 42567

**5B71668 THRUST
STRUCTURE INSTL**

$$\delta_{7,3} = \delta_{3,7}$$

$$\delta_{7,4} = \delta_{4,7}$$

$$\delta_{7,7} = \left(\frac{r^2}{E'A'} + \frac{d^2 r^2}{EI'} \right) x_7$$

$$\delta_{7,10} = \frac{+dr^2}{EI'} x_{10}$$

$$\delta_{7,11} = \frac{-dr^2}{EI'} x_{11}$$

$$\delta_{7,14} = \frac{+dr^2}{EI'} x_{14}$$

$$\delta_{7,N^3} = + \frac{N^3 \sin \theta r^2}{E'A'} - \frac{bd'r^2 N^3}{EI'}$$

$$\delta_{7,N^2} = - \frac{N^2 \sin \theta r^2}{E'A'} + \frac{bd'r^2 N^2}{EI'}$$

$$\delta_{7,N'} = + \frac{N' \sin \theta r^2}{E'A'} + \frac{d'a'r^2 N'}{EI'}$$

$$\delta_{7,T} = \alpha \Delta T r$$

PREPARED BY: J. R. H.

BOEING AIRCRAFT COMPANY INC.

CHECKED BY: G. J. S.DATE: 11/62TITLE: D.V - 4 PROPELLANT TANK

SM

DIVISION

PAGE: III 7.9MODEL: DSY-4REPORT NO: 13475-R-9587166B THRUST
STRUCTURE INSTL

$$\delta_{10,3} = \delta_{3,10}$$

$$\delta_{10,4} = \delta_{4,10}$$

$$\delta_{10,7} = \delta_{7,10}$$

$$\delta_{10,10} = \frac{x_{10}r^2}{EI'}$$

$$\delta_{10,11} = -\frac{x_{11}r^2}{EI'}$$

$$\delta_{10,14} = \frac{x_{14}r^2}{EI'}$$

$$\delta_{10,N^3} = -\frac{N^3 b r^2}{EI'}$$

$$\delta_{10,N^2} = \frac{N^2 b r^2}{EI'}$$

$$\delta_{10,N^1} = \frac{N^1 b r^2}{EI'}$$

$$\delta_{11,3} = \delta_{3,11}$$

$$\delta_{11,4} = \delta_{4,11}$$

$$\delta_{11,7} = \delta_{7,11}$$

$$\delta_{11,10} = \delta_{10,11}$$

$$\delta_{11,11} = \frac{x_{11}r^2}{EI'}$$

$$\delta_{11,14} = -\frac{x_{14}r^2}{EI'}$$

$$\delta_{11,N^3} = \frac{N^3 b r^2}{EI'}$$

$$\delta_{11,N^2} = -\frac{N^2 b r^2}{EI'}$$

$$\delta_{11,N^1} = -\frac{N^1 b r^2}{EI'}$$

$$\delta_{14,3} = \delta_{3,14}$$

$$\delta_{14,4} = \delta_{4,14}$$

$$\delta_{14,7} = \delta_{7,14}$$

$$\delta_{14,10} = \delta_{10,11}$$

$$\delta_{14,11} = \delta_{11,14}$$

$$\delta_{14,14} = \frac{x_{14}r^2}{EI'}$$

$$\delta_{14,N^3} = -\frac{N^3 b r^2}{EI'}$$

$$\delta_{14,N^2} = +\frac{N^2 b r^2}{EI'}$$

$$\delta_{14,N^1} = +\frac{N^1 b r^2}{EI'}$$

PREPARED BY: E.P.H.CHECKED BY: G.S.S.DATE: 11/10/2TITLE: PROPELLANT TANK

DODGE AIRCRAFT COMPANY, INC.

SM

DIVISION

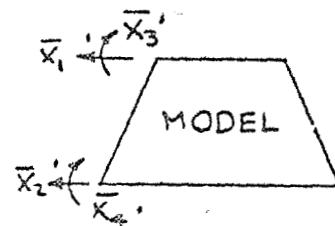
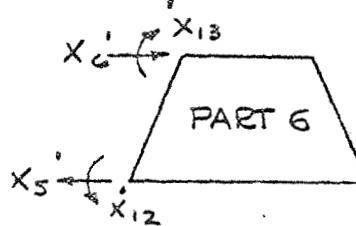
PAGE: III. 7.11MODEL: DSV-4REPORT NO: SM 42569PART 6587166B THRUST
STRUCTURE INSTL

$$X_5 = +\bar{X}_2$$

$$X_6 = -\bar{X}_1$$

$$X_{12} = -\bar{X}_4$$

$$X_{13} = +\bar{X}_3$$



$$\delta_{5,5} = +\bar{\delta}_{2,2}$$

$$\delta_{5,6} = -\bar{\delta}_{2,1}$$

$$\delta_{5,12} = -\bar{\delta}_{2,4}$$

$$\delta_{5,13} = +\bar{\delta}_{2,3}$$

$$\delta_{5,P} = \frac{PR^2(1-n)\sin\phi}{ZEt}$$

$$\delta_{5,T} = x\Delta T R \sin\phi$$

$$\delta_{12,5} = -\bar{\delta}_{4,2}$$

$$\delta_{12,6} = +\bar{\delta}_{4,1}$$

$$\delta_{12,12} = +\bar{\delta}_{4,4}$$

$$\delta_{12,13} = -\bar{\delta}_{4,3}$$

$$\delta_{12,T} = 0'$$

$$\delta_{13,P} = 0'$$

$$\delta_{6,5} = -\bar{\delta}_{1,2}$$

$$\delta_{6,6} = +\bar{\delta}_{1,1}$$

$$\delta_{6,12} = +\bar{\delta}_{1,4}$$

$$\delta_{6,13} = -\bar{\delta}_{1,3}$$

$$\delta_{6,P} = -\bar{\delta}_{5,P}$$

$$\delta_{6,T} = -\bar{\delta}_{5,T}$$

$$\delta_{13,5} = +\bar{\delta}_{3,2}$$

$$\delta_{13,6} = -\bar{\delta}_{3,1}$$

$$\delta_{13,12} = -\bar{\delta}_{3,4}$$

$$\delta_{13,13} = +\bar{\delta}_{3,3}$$

$$\delta_{13,P} = 0'$$

$$\delta_{13,T} = 0'$$

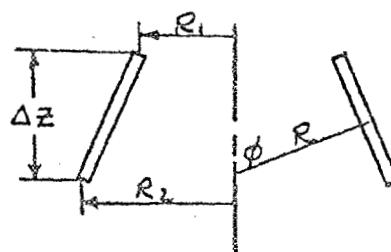
$$R = 109.708'$$

$$\phi = 53^\circ 34'$$

$$R_1 = 87.821'$$

$$R_2 = 88.711'$$

$$\Delta Z = 1.2068'$$



PREPARED BY G.A.H.
CHECKED BY S.T.S.
DATE 11/62
TITLE DSV-4 PROPELLANT TANK

DOUGLAS AIRCRAFT COMPANY, INC.

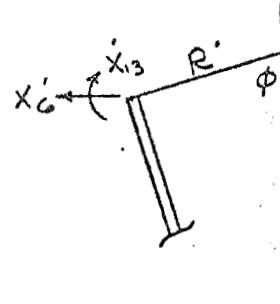
SM

DIVISION

PAGE III, 7, 12
MODEL DSV-4
REPORT NO. SM 4256 9

PART 7

5871668 THRUST
STRUCTURE INSTL



$$\delta_{6,6}^7 = -\frac{x_6}{E_t} BR \sin^2 \phi (K_2 + \frac{1}{R})$$

$$\delta_{6,13}^7 = \frac{zB^2 \sin \phi}{E_t K_1} x_{13}$$

$$\delta_{6,P}^7 = \frac{PR^2(1-\bar{\nu}) \sin \phi}{zE_t}$$

$$\delta_{6,T}^7 = \alpha \Delta T R \sin \phi$$

$$\delta_{13,6}^7 = \delta_{6,13}^7$$

$$\delta_{13,13}^7 = \frac{4B^3 x_{13}}{E_t R K_1}$$

$$R = 109.738'$$

$$\phi = 53^\circ 11'$$

$$B = \left[3(1-\bar{\nu}^2) \left(\frac{R}{t} \right)^2 \right]^{1/4}$$

$$K_1 = 1 - \frac{1-2\bar{\nu}}{2B} \cot \phi$$

$$K_2 = 1 - \frac{1+2\bar{\nu}}{2B} \cot \phi$$

4-26-61
V. 2-28

PREPARED BY J.R.H.
CHECKED BY G.T.S.
DATE 11/16/62
TITLE DSV-4 PROPELLANT TANK

DOUGLAS AIRCRAFT COMPANY, INC.

SM

DIVISION

PAGE III, 7.13

MODEL DSV-4

REPORT NO. SM 42-52-3

PART 8

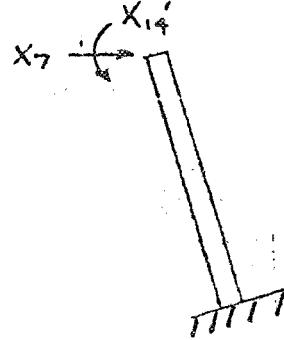
587166B THRUST
STRUCTURE INSTL

$$\delta_{7,7}^8 = 1.3190 \times 10^{-2} X_7$$

$$\delta_{7,14}^8 = -0.0689 \times 10^{-2} X_{14}$$

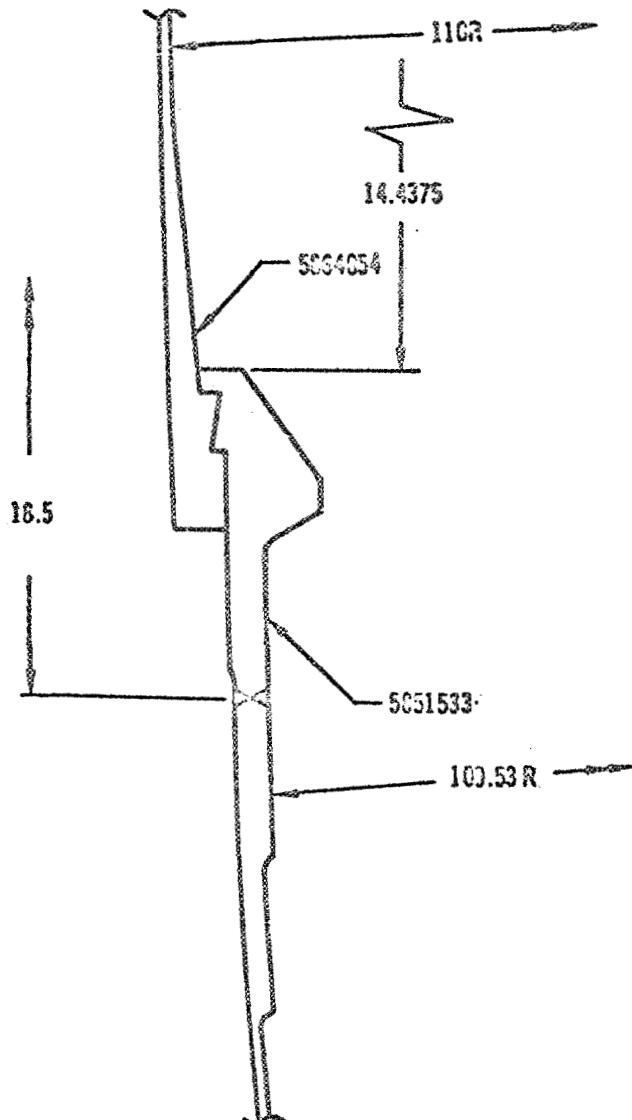
$$\delta_{14,7}^8 = \delta_{7,14}^8$$

$$\delta_{14,14}^8 = .0048 \times 10^{-2} X_{14}$$



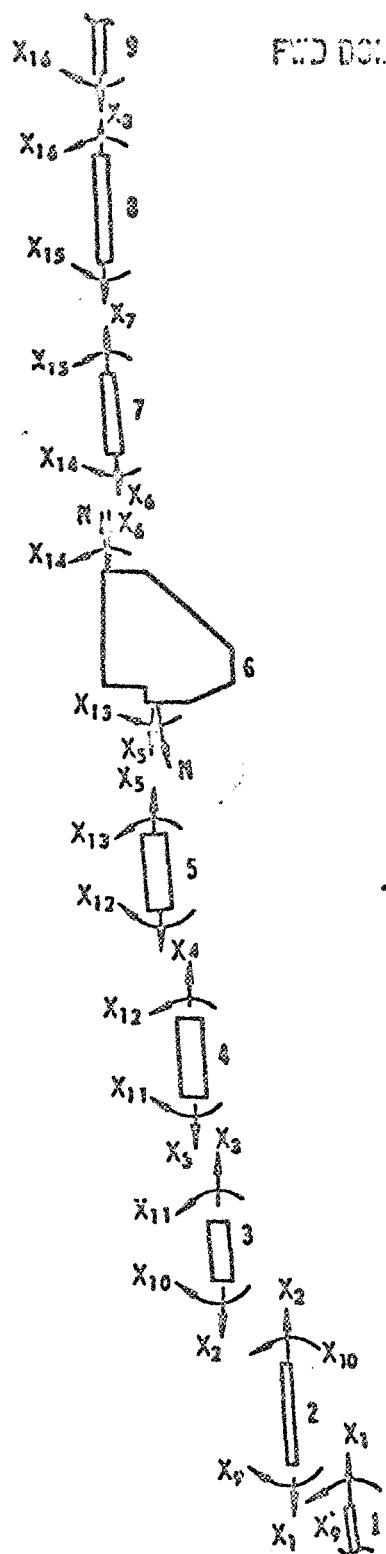
SC11217 WIG TANK
DOOR INSTL

5033000
STRUCTURE ASSY



STRUCTURE ASSY

FWD DOME - DOOR JOINT



PREPARED BY: G.R.B.
CHECKED BY: J.C.Y.
DATE: 2/24/68

FOUCAULT AIRCRAFT COMPANY, INC.

SM

DIVISION

PAGE: III P.2MODEL: DSV-4REPORT NO: S-142569TITLE: DSV-4 PROPELLANT TANK

5863800

STRUCTURE ASSY

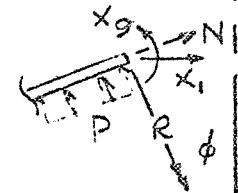
PART 1
SPHERE

$$B^4 = 3(1-v^2) \frac{R^2}{t^2}$$

$$T < 70^\circ$$

$$K_1 = 1 + \frac{1-2v}{2\beta} \cot \phi$$

$$K_2 = 1 + \frac{1+2v}{2\beta} \cot \phi$$



$$\delta_{1,1} = \frac{x_1}{E \epsilon t} B R \sin^2 \phi (K_2 + \frac{1}{K_1})$$

$$\delta_{1,P} = -\frac{PR^2(1-v)}{2E \epsilon t} \sin \phi$$

$$\delta_{1,g} = -\frac{x_g 2\beta^2 \sin \phi}{E \epsilon t K_1}$$

$$\delta_{1,T} = -\alpha \Delta T R \sin \phi$$

$$\delta_{g,1} = \delta_{1,g}$$

$$\delta_{g,g} = \frac{x_g 4 B^3}{E \epsilon t R K_1}$$

PART 2
CONE

$$\delta_{11} = +\delta_{22}$$

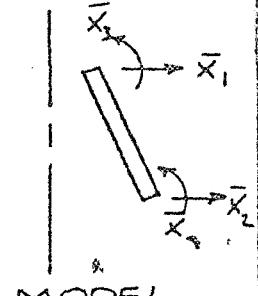
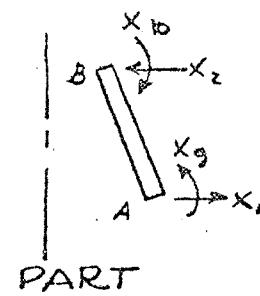
$$\delta_{12} = -\delta_{21}$$

$$\delta_{1g} = +\delta_{24}$$

$$\delta_{1,10} = -\delta_{2,3}$$

$$\delta_{1,P} = \frac{PR^2(1-v)}{2E \epsilon t} \sin \phi$$

$$\delta_{1,T} = +\alpha \Delta T R \sin \phi$$



PREPARED BY G.R.A.
CHECKED BY M.C.Z.
DATE 2-15-68
TITLE REV-A PROPELLANT TANK

DODGE AIRCRAFT COMPANY, INC.

SM

DIVISION

PAGE III. 8.3MODEL DSV-4REPORT NO. SII 42569

5863800

STRUCTURE ASSY

$$\delta_{z1} = -\bar{\delta}_{12}$$

$$\delta_{zz} = +\bar{\delta}_{11}$$

$$\delta_{z,p} = -\frac{PR^2(1-\nu)}{2Eh} \sin\phi$$

$$\delta_{z9} = -\bar{\delta}_{14}$$

$$\delta_{z,r} = -\alpha \Delta T R \sin\phi$$

$$\delta_{z,10} = +\bar{\delta}_{13}$$

$$\delta_{9,1} = +\bar{\delta}_{42}$$

$$\delta_{10,1} = -\bar{\delta}_{32}$$

$$\delta_{9,2} = -\bar{\delta}_{41}$$

$$\delta_{10,2} = +\bar{\delta}_{31}$$

$$\delta_{9,9} = +\bar{\delta}_{49}$$

$$\delta_{10,4} = -\bar{\delta}_{34}$$

$$\delta_{9,10} = -\bar{\delta}_{43}$$

$$\delta_{10,10} = +\bar{\delta}_{33}$$

$$R_1 = 21.6306$$

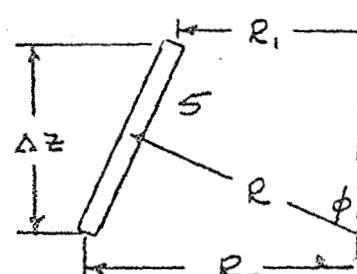
$$R_2 = 30.2515$$

$$R = 109.75$$

$$\Delta z = 2.0995$$

$$t = .057$$

$$\phi = 14^\circ 6'$$



PREPARED BY: G. R. G.
CHECKED BY: ME
DATE: 10-3
TITLE: DSV-4 PROPELLENT TANK

Douglas Aircraft Company, Inc.

SM

DIVISION

PAGE: III.8.4
MODEL: DSV-4-
REPORT NO. SMA 2369

PART 3

CONE

5863800
STRUCTURE ASSY

$$\delta_{22} = +\delta_{22}$$

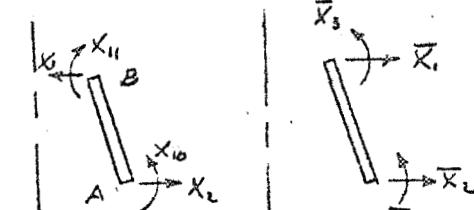
$$\delta_{23} = -\delta_{21}$$

$$\delta_{310} = +\delta_{24}$$

$$\delta_{211} = -\delta_{23}$$

$$\delta_{2,P} = \frac{PR^2(1-U)\sin\phi}{ZET}$$

$$\delta_{2,T} = \alpha \Delta TR \sin\phi$$



PART MODEL
SAB PROGRAM

$$\delta_{3,2} = -\bar{\delta}_{12}$$

$$\delta_{3,3} = +\bar{\delta}_{11}$$

$$\delta_{3,10} = -\bar{\delta}_{14}$$

$$\delta_{3,11} = +\bar{\delta}_{13}$$

$$\delta_{3,P} = -\delta_{2,P}$$

$$\delta_{3,T} = -\delta_{2,T}$$

$$\delta_{10,2} = +\delta_{42}$$

$$\delta_{10,3} = -\delta_{41}$$

$$\delta'_{10,10} = +\delta_{44}$$

$$\delta_{10,11} = -\delta_{43}$$

$$\delta_{11,2} = -\delta_{32}$$

$$\delta_{11,3} = +\delta_{31}$$

$$\delta_{11,10} = -\delta_{34}$$

$$\delta_{11,11} = +\delta_{33}$$

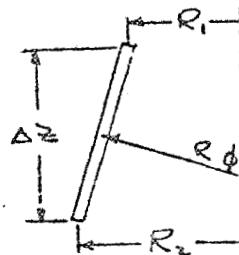
$$R_1 = 20.125$$

$$R_2 = 21.625$$

$$\Delta Z = .2907$$

$$t = .125$$

$$\phi = 10^\circ 58'$$



PREPARED BY: G.H.
 CHECKED BY: J.C.Y.
 DATE: 8-63
 TITLE: DSV-4 PELLETANT TIME

Douglas Aircraft Company, Inc.

SM

DIVISION

PAGE III. 8.5
 MODEL DSV-4

REPORT NO. SJ 12569

PART 4
CONE

5863800
STRUCTURE ASSY

$$\delta_{3,3} = + \bar{\delta}_{22}$$

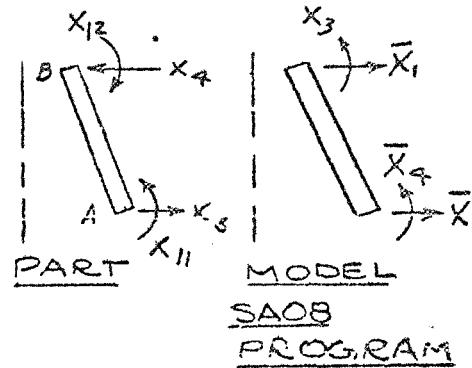
$$\delta_{3,4} = - \bar{\delta}_{21}$$

$$\delta_{3,11} = + \bar{\delta}_{24}$$

$$\delta_{3,12} = - \bar{\delta}_{23}$$

$$\delta_{3,P} = + \frac{P R^2 (1-\nu)}{Z E t} \sin \phi$$

$$\delta_{3,T} = + \alpha \Delta T R \sin \phi$$



$$\delta_{4,3} = - \bar{\delta}_{12}$$

$$\delta_{4,4} = + \bar{\delta}_{11}$$

$$\delta_{4,11} = - \bar{\delta}_{14}$$

$$\delta_{4,12} = + \bar{\delta}_{13}$$

$$\delta_{4,P} = - \bar{\delta}_{2,P}$$

$$\delta_{4,T} = - \bar{\delta}_{2,T}$$

$$\delta_{11,3} = + \bar{\delta}_{42}$$

$$\delta_{11,4} = - \bar{\delta}_{41}$$

$$\delta_{11,11} = + \bar{\delta}_{44}$$

$$\delta_{11,12} = - \bar{\delta}_{43}$$

$$\delta_{12,3} = - \bar{\delta}_{32}$$

$$\delta_{12,4} = + \bar{\delta}_{31}$$

$$\delta_{12,11} = - \bar{\delta}_{34}$$

$$\delta_{12,12} = + \bar{\delta}_{33}$$

$$R_1 = 18.500$$

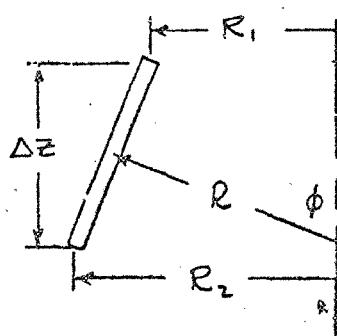
$$R_2 = 20.125$$

$$R = 109.655$$

$$\Delta Z = .2909$$

$$t = .25$$

$$\phi = 10^\circ 9'$$



PREPARED BY G.R.H.
CHECKED BY T.C.P.
DATE 8-3
TITLE DSV-4 OCSPRELLANT TANK

DOUGLAS AIRCRAFT COMPANY INC.

SM DIVISION

Page III, 8, 6
MODEL DSV-4REPORT NO SIL42563PART 5
CONE5863500
STRUCTURE ASSY

$$\delta_{4,4} = + \bar{\delta}_{22}$$

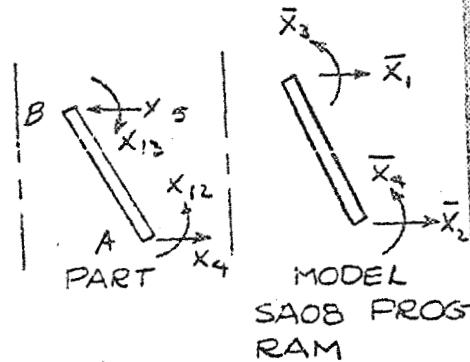
$$\delta_{4,5} = - \bar{\delta}_{21}$$

$$\delta_{4,12} = + \bar{\delta}_{24}$$

$$\delta_{4,13} = - \bar{\delta}_{23}$$

$$\delta_{4,P} = + \frac{PR^2(1-\nu)}{2Et} \sin \phi$$

$$\delta_{4,T} = + \alpha \Delta T R \sin \phi$$



$$\delta_{5,4} = - \bar{\delta}_{12}$$

$$\delta_{5,5} = + \bar{\delta}_{11}$$

$$\delta_{5,12} = - \bar{\delta}_{14}$$

$$\delta_{5,13} = + \bar{\delta}_{13}$$

$$\delta_{5,P} = - \bar{\delta}_{3,P}$$

$$\delta_{5,T} = - \bar{\delta}_{3,T}$$

$$\delta_{12,4} = + \bar{\delta}_{42}$$

$$\delta_{12,5} = - \bar{\delta}_{41}$$

$$\delta_{12,12} = + \bar{\delta}_{44}$$

$$\delta_{12,13} = - \bar{\delta}_{43}$$

$$\delta_{13,4} = - \bar{\delta}_{32}$$

$$\delta_{13,5} = + \bar{\delta}_{31}$$

$$\delta_{13,12} = - \bar{\delta}_{34}$$

$$\delta_{13,13} = + \bar{\delta}_{33}$$

$$R_1 = 16.233$$

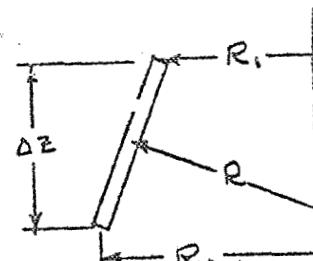
$$R_2 = 18.500$$

$$R = 109.718^\circ$$

$$\Delta Z = .193^\circ$$

$$t = .375^\circ$$

$$\phi = 4^\circ 52'$$



PREPARED BY: C.R.A.
CHECKED BY: G.J.C
DATE: 8-6-73
TITLE: DSV-4 PROPELLANT TANK

DUGLASS AERONAUTIC COMPANY, INC.

SM

DIVISION

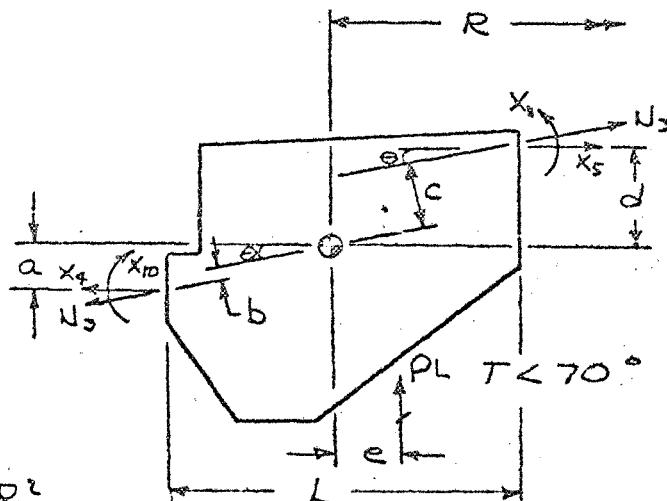
PAGE III, 8,7

MODEL: DSV-4

REPORT NO: 342568

PART 6
RING

5863800
STRUCTURE ASSY



$$\delta_{5,5} = \frac{x_5 R^2}{EA} + \frac{x_5 a^2 R^2}{EI}$$

$$\delta_{5,6} = -\frac{x_6 R^2}{EA} + \frac{x_6 a^2 R^2}{EI}$$

$$\delta_{5,13} = +\frac{x_{13} a^2 R^2}{EI}$$

$$\delta_{5,14} = -\frac{x_{14} a^2 R^2}{EI}$$

$$\epsilon_{5,N_3} = +\frac{N_3 a b R^2}{EI} + \frac{N_3 a c R^2}{EI}$$

$$\delta_{5,T} = +\alpha \Delta T R ; \quad \delta_{5,P} = -PLc \frac{R^2}{EI} a$$

$$\delta_{6,5} = +\delta_{5,6}$$

$$\delta_{6,6} = \frac{x_6 R^2}{EA} + \frac{x_6 d^2 e^2}{EI}$$

$$\delta_{6,13} = +\frac{x_{13} d^2 R^2}{EI}$$

PREPARED BY J. P. H.
CHECKED BY J. S.
DATE 9-23
TITLE 541-A EXHAUST TANK

BOEING AIRCRAFT COMPANY, INC.

SM

DIVISION

PAGE III, 9

MODEL DSV-4

REPORT NO SM 42569

5863800

STRUCTURE ASSY

$$\delta_{6,14} = -\frac{x_{14}dR^2}{EI}$$

$$\delta_{6,N_3} = \frac{N_3 bd R^2}{EI} + \frac{N_3 cd R^2}{EI}$$

$$\delta_{6,T} = -\alpha \Delta T R ; \quad \delta_{6,P} = -PLde \frac{R^2}{EI}$$

$$\delta_{13,5} = \delta_{5,13}$$

$$\delta_{13,6} = \delta_{6,13}$$

$$\delta_{13,D} = -PLe \frac{R^2}{EI}$$

$$\delta_{13,13} = \frac{x_{13}R^2}{EI}$$

$$\delta_{13,14} = -\frac{x_{14}R^2}{EI}$$

$$\delta_{13,N_3} = \frac{N_3(c+b)R^2}{EI}$$

$$\delta_{14,5} = \delta_{5,14}$$

$$\delta_{14,6} = \delta_{6,14}$$

$$\delta_{14,P} = +PLe \frac{R^2}{EI}$$

$$\delta_{14,13} = \delta_{13,14}$$

$$\delta_{14,14} = \frac{x_{14}R^2}{EI}$$

$$\delta_{14,N_3} = -\frac{N_3(b+c)R^2}{EI}$$

PREPARED BY: GPA
 CHECKED BY: JLS
 DATE: 2-10-31
 TITLE: DCV-4 PROPELLANT TANK

DEFENSE CONTRACTOR CONSTRUCTION DRAWINGS

SM

DIVISION

PAGE: III, P. 9
MODEL: DSV-4

REPORT NO: 114263-9

PART 7CONE

5863800

STRUCTURE ASSY

$$\delta_{6,6} = +\bar{\delta}_{zz}$$

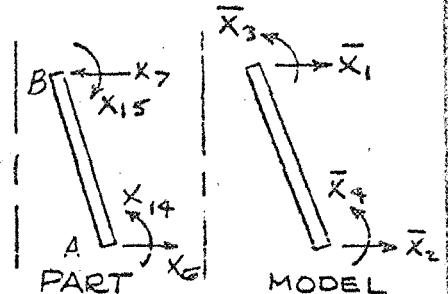
$$\delta_{6,7} = -\bar{\delta}_{z1}$$

$$\delta_{6,14} = +\bar{\delta}_{z4}$$

$$\delta_{6,15} = -\bar{\delta}_{z3}$$

$$\delta_{6,p} = \frac{PR^2(1-\nu)}{ZEt} \sin \phi$$

$$\epsilon_{6,r} = +\alpha \Delta TR \sin \phi$$



$$\delta_{7,6} = -\bar{\delta}_{iz}$$

$$\delta_{7,7} = +\bar{\delta}_{ii}$$

$$\delta_{7,14} = -\bar{\delta}_{i4}$$

$$\delta_{7,15} = +\bar{\delta}_{i3}$$

$$\delta_{7,p} = -\bar{\delta}_{5,p}$$

$$\delta_{7,r} = -\bar{\delta}_{5,r}$$

$$\delta_{14,6} = +\bar{\delta}_{4z}$$

$$\delta_{14,7} = -\bar{\delta}_{41}$$

$$\delta_{14,14} = +\bar{\delta}_{44}$$

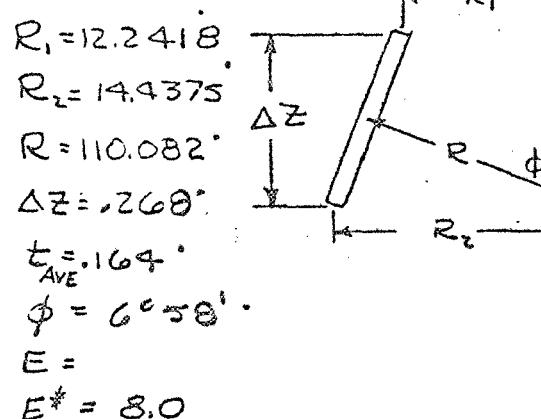
$$\delta_{14,15} = -\bar{\delta}_{43}$$

$$\delta_{15,6} = -\bar{\delta}_{3z}$$

$$\delta_{15,7} = +\bar{\delta}_{31}$$

$$\delta_{15,14} = -\bar{\delta}_{34}$$

$$\delta_{15,15} = +\bar{\delta}_{33}$$



* DENOTES SECANT E , REF P 2.16

PREPARED BY: C.R.H.
CHECKED BY: M.E.
DATE: 10-3
TITLE: OSV-4 PO: NELLANT TANK

STANDBY AIRCRAFT COMPANY, INC.

SM

DIVISION

PAGE: III. C.10

MODEL: OSV-4

REPORT NO. SM 42569

PART 8
CONE

5863800
STRUCTURE ASSY

$$\delta_{7,7} = + \delta_{22}$$

$$\epsilon_{7,8} = - \delta_{21}$$

$$\delta_{7,15} = + \delta_{29}$$

$$\delta_{7,16} = - \delta_{23}$$

$$\delta_{7,P} = \frac{PR^2(1-\delta) \sin \phi}{ZET}$$

$$\delta_{7,T} = \alpha \Delta TR \sin \phi$$

$$\delta_{8,7} = - \delta_{12}$$

$$\delta_{8,8} = + \delta_{11}$$

$$\delta_{8,15} = - \delta_{14}$$

$$\delta_{8,16} = + \delta_{13}$$

$$\delta_{8,P} = - \delta_{7,P}$$

$$\delta_{8,T} = - \delta_{7,T}$$

$$\delta_{16,7} = - \delta_{32}$$

$$\delta_{16,8} = + \delta_{31}$$

$$\delta_{16,15} = - \delta_{34}$$

$$\delta_{16,16} = + \delta_{33}$$

$$R_1 = 14.7429$$

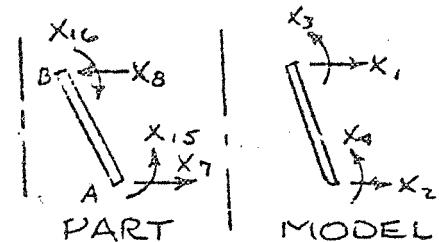
$$\Delta Z = .8417$$

$$R_2 = 5.7590$$

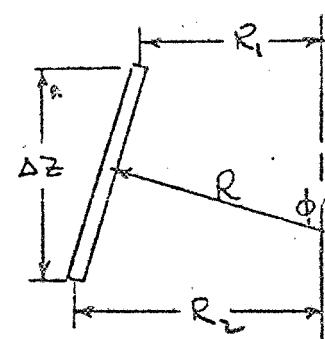
$$t = .063$$

$$R = 1.0103$$

$$\phi = 5^\circ 21'$$



SA08
PROGRAM



* DENOTES SECANT E, REF P 2.16

PREPARED BY C. J. RAY
CHECKED BY SAC Y.
DATE 3-3

STRUCTURES DIVISIONS COMPANY, INC.

SM

DIVISION

PAGE III. 8, 11

MODEL DSV-4

REPORT NO SH 142569

TITLE DSV-4 FUEL TANK

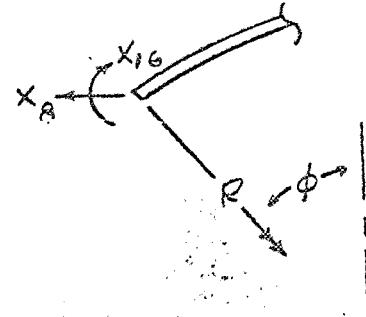
PART 9
SPHERE

5863800
STRUCTURE ASSY

$$\beta = 3(1-\nu^2) \frac{R^2}{t^2}$$

$$K_1 = 1 - \frac{1-2\nu}{2\beta} \cot \phi$$

$$K_2 = 1 - \frac{1+2\nu}{2\beta} \cot \phi$$



$$\delta_{\theta, \theta} = \frac{X_\theta}{E t} \beta R \sin^2 \phi (K_2 + \frac{1}{K_1})$$

$$\delta_{\theta, 16} = \frac{X_{16}}{E t} \frac{(2B^2 \sin \phi)}{K_1}$$

$$\epsilon_{\theta P} = \frac{PR^2(1-\nu)}{2Et} \sin \phi$$

$$\delta_{\theta, T} = + \alpha \Delta T R \sin \phi$$

$$\delta_{16, \theta} = \delta_{\theta, 16}$$

$$\delta_{16, 16} = \frac{X_{16} 4 \beta^3}{E t R K_1}$$

Distribution Sheet

Report SI-42569

S. D. Truhan, A3-120

F. S. Meyer, A3-860

L. S. Hull, A3-860

Strength Section File, A3-860